ENVIRONMENTAL IMPACT STATEMENT

final

ENVIRONMENT

KAIPAROWITS

ENERGY

United States
Department of the Interior

CHAPTER II

KAIPAROWITS

ENVIRONMENTAL IMPACT STATEMENT

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DESCRIPTION OF THE ENVIRONMENT

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SUMMARY

Climate

Climate of the Kaiparowits Plateau impact area is arid to semiarid with considerable geographic, seasonal and annual variation. Average annual precipitation ranges from less than 6 to about 10 inches. Winter snowstorms and summer thunderstorms are the important sources of precipitation. Transpiration from plants and evaporation from soil and water surfaces are high. Winter air temperatures at various locations within the Kaiparowits Plateau impact area range from the low to mid 30's. Summer air temperatures range from the high 70's to mid 80's. Extremes vary from less than 0° F in winter to more than 100° F in summer.

The climate of the transmission system impact area varies over the more than 1,400-mile length. Generally, the proposed transmission routes pass through two broad climatic zones. In southern Utah, southeastern Nevada, central and western Arizona, and southeastern California, the climate is arid to semiarid Continental. Summers are hot and winters are mild with precipitation almost equally distributed between summer and winter. In southwestern California the climate is Mediterranean, with hot, dry summers and moist, mild winters. Only about 11 percent of the proposed transmission system is within the Mediterranean climatic zone, the remainder is within the Continental climatic zone.

The limestone quarry impact area is cooler than the other areas. The area receives from 12 to 16 inches annual precipitation.

Air quality

Measurements in the Kaiparowits-Lake Powell area indicate air quality is generally excellent. Background levels of particulates are variable ranging from 1 microgram per cubic meter ($\mu g/m^3$) to over 500 $\mu g/m^3$, with annual averages of approximately 30 $\mu g/m^3$. Higher concentrations are associated with windy conditions. Sulfur dioxide (SO_2) measurements made at Page, Arizona, are low and range between approximately 0.01 to 0.032 parts per million (ppm) for daily mean concentrations. Sulfation rate measurements showed a general increase in 1974 as compared to 1973 rates. Most likely this increase was influenced by the 1974 start-up of the Navajo plant near Page. The SO_2 measurements made by the Arizona Bureau of Air Quality Control showed an annual increase from 0.0004 in 1973 to 0.003 ppm in 1974 and a 24-hour maximum concentration increase from 0.004 in 1973 to 0.008 ppm in 1974. Nitrogen oxide measurements made at Page were generally low but have shown an increase from 0.005 ppm in 1973 to 0.012 ppm in 1974. Twenty-four hour maximum concentrations showed an increase from 0.024 to 0.066 ppm. Oxidant levels ranged between 0.011 ppm and 0.037 ppm compared with global average background concentrations of 0.015 to 0.030 ppm. Measurements of trace element concentration in the air reflected relatively low levels. No measurement of radioactive elements in the air is presently being made in the area. Visibility is generally excellent, averaging greater than 70 miles. However, measurements made from Page, Arizona of local visual range and long-path measurement of regional visibility have indicated a measureable decrease in visual range from 1972 to 1974. A periodic yellow discoloration associated with the Navajo plant emissions has been observed extending downwind from the plant stacks. The average atmospheric transport and mixing characteristics of the region result in good dispersion conditions throughout most of the year, particularly during the spring and summer months. The resultant large scale transport is toward the northeast.

Prevailing surface winds are from the west, strongest in the spring and early summer and lightest in the fall and winter. Net air movement from winds aloft over the site is generally from the west and southwest. Neutral atmospheric conditions (a temperature change of 5.4° F per 1,000 feet which is conducive to vertical and horizontal pollution dispersion) to slightly-stable atmospheric conditions (a temperature change with height which is conducive to restricted vertical pollution dispersion) predominate in the range of expected plume elevation. Neutral to slightly-stable conditions are most prevalent during the morning hours with predominantly neutral conditions occurring in the afternoon. During the winter, low-level surface inversions are common, frequently being strong enough to maintain themselves throughout the day. This condition would be conducive to the trapping of surface-released pollutants but on the other hand, it would also tend to inhibit an elevated release (such as emissions from tall stacks) from reaching the ground. Limited dispersion conditions, often associated with regional stagnation and the buildup of air pollution levels, can be expected to occur on the average of two to four times per winter with an average duration of 5 to 7 days. During these periods emissions could be confined to the Lake Powell Basin.

Most of the proposed transmission line system crosses sparsley-populated areas where air quality is generally good to excellent. However, there are short periods of occasional degradation caused by localized winds that stir up large quantities of sand and dust. Serious air quality conditions do occur along the heavier-populated segments of the system in California, where federal air quality standards are routinely violated.

Air quality in the limestone quarry impact area can be expected to be excellent. Air quality data has not been collected, however the quarry is located in an area that is remote from air pollution sources such as industries and population centers.

Geology and topography

The Kaiparowits Plateau lies wholly within the Canyonlands section of the Colorado Plateau physiographic province. Elevations range from 3,000 to 8,000 feet. The impact area consists of gently folded sedimentary rocks eroded to form benches bounded by steep cliffs and winding canyons. The canyons are deepest near the cliffs, which bound the benches, and decrease in depth as they rise toward the bench tops.

The important coal resources are contained within several coal zones in the Straight Cliffs Formation. Recoverable reserves in the Kaiparowits Plateau exceed 15 billion tons. The participants estimate 1.5 billion tons of coal lie within their lease holding. About 92 million tons of coal underlie the proposed plant site. Coal within the lease holding has a moderate heating value, ranging from 10,600 to 11,000 British thermal units per pound.

Other mineral resources in the plateau include oil (one field), limestone, aggregate, common clays, and bentonitic mudstones.

The transmission system impact area includes five physiographic provinces. These are: the Plateau Province, characterized by broad and flat plateaus bounded by steep-sided canyons; the Transition Zone, consisting of rugged mountains; the Basin and Range Province, consisting of rugged mountain ranges separated by wide valleys; the Salton Trough, characterized as a low-lying desert basin; and the Peninsular Range Province, consisting of a series of north-west trending mountain ranges and valleys. There are several active faults within the transmission system impact area.

The limestone quarry area is on one of a series of limestone ridges bordering Johns Valley, north of Bryce Canyon National Park.

Soils

Within the Kaiparowits Plateau impact area there are 5 soil associations, which vary from deep medium textured to shallow and rocky. Most of these soils contain small to moderate amounts of exchangeable sodium. The erosion condition varies from slight to severe with water absorption rates varying from 0.5 to 3.5 inches per hour. The potential for reseeding varies from less than 3 years out of 10 years, to 3 to 5 years out of 10 years. The erosion susceptibility, should existing vegetation be disturbed, varies from slight to moderate.

The soils found along the transmission alignment vary from sands to clays, from highly erosive to stable, bare rock to deep soils, and non-productive to productive. There are 73 soil associations along the system. These soils were rated for erosion hazard, of which 12 percent are low, 46 percent are moderate, 25 percent are moderate to severe, and 17 percent are severe. The rehabilitation potential considered that 72 percent are low, 24 percent are moderate and the remaining 4 percent are high.

The limestone quarry area contains one soil association that varies from shallow to moderately deep and is neutral to moderately acid. These soils are moderately to excessively drained with a moderate erosion susceptibility. The potential for rehabilitation success is considered to be greater than 7 years out of 10 years.

Water resources

The Kaiparowits Plateau impact area is within the Colorado River Basin. Readily available and dependable sources of water have historically been in short supply over large portions of this basin. Consequently, the use of water within the basin has been strictly allocated to various water users. Based on different interpretations of the laws and various assumptions relating to storage, regulation, and nature of use of water, Utah's share in the Upper Colorado River Basin ranges from less than 1,320,000 to 1,700,000 acre-feet per year.

Ground water occurs at varying depths throughout the plateau impact area. An estimated 800,000 acre-feet of water are available from the upper 100 feet of saturated rocks, and an estimated average annual replenishable ground water supply (by seepage for precipitation) of about 30,000 acre feet. The ground water ranges from fresh to moderately saline. Depths to the regional water table range from less than 100 feet beneath canyon bottoms to more than 1,000 feet beneath plateau tops. Shallow perched aquifers occur locally in rock strata above the regional water table. These aquifers support the flow of small seeps and springs, (annually less than 20 gallons per minute) but are not capable of supporting large sustained withdrawals by wells. The most extensive and productive aquifers are in the Navajo Sandstone. This formation is exposed at the land surface around the margins of the Kaiparowits Plateau, but occurs at depths of 1,000 to 4,000 feet beneath the higher benches in the plateau. Aquifers in the Navajo Sandstone are capable of yielding several hundred to more than a thousand gallons per minute of fresh water to wells.

Glen Canyon Dam impounds a section of the Colorado River to form Lake Powell. Lake Powell is a multipurpose storage reservoir which inundates the southeastern side of the Kaiparowits Plateau impact area. Usable storage capacity (including bank storage) is about 33 million acre feet. Concentrations of dissolved solids in Wahweap Bay of Lake Powell have ranged from 550 to 813 milligrams per liter.

All streams draining the plateau are intermittant. They are subject to periods of intense flooding, usually caused by late summer thunderstorms. These streams have little value as dependable supplies of water.

The principle water sources for largescale development in the area are Lake Powell and deep aquifers in the Navajo Sandstone. This water is suitable for most industrial, agricultural, municipal, wildlife, and recreational uses. Lake Powell is presently used as a municipal water supply for Page, Arizona, and as an industrial water supply for the Navajo power plant. It is also extensively used for wildlife and recreational purposes. Aquifers in the Navajo Sandstone have been tapped by several wells. Wells supply water for domestic use and for fish culture in the Glen Canyon City area.

The low yielding perched aquifers would not support largescale development. However, the aquifers are important since the discharge from them appears as springs and seeps that are sources of drinking water for livestock, wildlife, and campers.

Most ground water in the transmission system impact area is in basins crossed by the proposed routes. The major uses of water in the transmission system impact area, in order of importance, are agricultural, domestic, and industrial. Ground water has been the major source supplying these needs. Increasing water demand has caused greater use of perennial streams to supply water. Although numerous dry washes cross the area and may become flooded during rainstorms, the washes have no value as a dependable source of water.

The limestone quarry impact area contains several small springs that provide water for livestock and wildlife. Vegetation indicates ground water is within 50 feet of the surface. This area is within the Upper Sevier River Basin. Water from the Sevier River is used almost entirely for irrigation, and the river is fully appropriated. Because of the close relationship between ground and surface water, issuance of permits to divert additional ground water is restricted.

Vegetation

The Kaiparowits Plateau is ecologically unique because of the blending of cold-desert and warm-desert species, with wide diversity of plant life. There are areas representing a variety of successional stages preceding the final or mature (climax) conditions, as well as areas having all characteristics of the climax state. The major vegetation types present include pinyon-juniper woodland, mixed desert-shrub, salt desert brush, desert grassland, and sage-brush. At least 11 species classified as threatened or endangered under the Endangered Species Act of 1973 occur within the plateau.

Pinyon-juniper woodland on Fourmile Bench has many characteristics of a climax condition and contains a large number of old trees. One 1400-year old juniper has been identified. Vegetation on the proposed townsite of East Clark Bench is primarily mixed desert shrub. Species diversity is lower than adjacent less arid areas, and vegetative cover is low. The coal mine area is predominantly salt brush and mixed desert-shrub vegetation with sparse ground cover.

Twelve major plant communities would be crossed by the proposed transmission system. These communities are the pinyon-juniper woodland, Great Basin desert shrub, plains and desert grassland, Mohave desert shrub, riparian woodland, interior chaparral, coastal chaparral, Sonoran desert shrub (lower Colorado), Sonoran desert shrub (Arizona upland), coastal sage shrub, urban agricultural, and Joshua tree woodland. Vegetative productivity within the transmission system area is extremely variable from year to year, both between plant communities and within the same plant communities, due to greatly increased production of annuals in years of above average precipitation. Rare are endangered plants listed by the California Native Plant Society and native plants protected by Arizona Law are found within the proposed transmission corridors.

The limestone quarry area overstory is dominated by two-needle pinyon pine and Utah juniper. Small groves or scattered trees of ponderosa pine and Rocky Mountain juniper occur. Western bristle-cone pine occur in two locations within the proposed quarry area. Open areas are dominated by shrub-grass mixtures, primarily sagebrush, rabbit brush, blue grass, stipa and blue grama grasses. One species in the area has been classified as threatened under the Endangered Species Act of 1973.

Wildlife

Wildlife of the Kaiparowits Plateau impact area is characterized by diversity of species rather than dense populations. The plateau varies greatly in elevation and topography and is in a climatic zone where northern and southern habitat types intermingle. These factors have produced a diverse fauna. Arid climate and resultant sparse vegetation limit populations of many species.

Deer, pronghorn antelope, mountain lion, coyotes, foxes, and bobcats are the principal large mammals. Over 200 species of birds, including eagles, use the plateau at least seasonally. Thirty species of small mammals, and 31 species of reptiles and amphibians occur throughout the plateau. Desert bighorn inhabited the area historically, and the State of Utah plans their reintroduction on Fiftymile Mountain adjacent to the east.

Sport fishery habitat of the plateau impact area is almost completely limited to the waters of Lake Powell, which is primarily a warm water habitat although the cold, deep water near the dam supports rainbow trout. The reservior supports excellent populations of largemouth bass, walleye, crappie, bluegill, and catfish. Striped bass were recently introduced and are making excellent growth. Some larger game fish in Lake Powell have a mercury level exceeding 500 parts per billion. This mercury apparently comes largely from natural sources

throughout the watershed. Streams draining the plateau are largely intermittent and silt laden, supporting no game fish.

Paunsaugunt, Sevier, and Aquarius plateaus and Boulder Mountain north of the Kaiparowits Plateau impact area are within a zone of secondary project influence. These high, forested plateaus support populations of wildlife, including mule deer, forest grouse, band tailed pigeons, sage grouse, and wild turkeys. Small birds and mammals, predators, raptors and fur animals are also present. The Utah prairie dog, an endangered species, occurs in portions of this area. Waterfowl and shore birds nest on some shallow, marsh bordered lakes and ponds on the plateaus.

Good quality cold water fish habitat occurs in numerous small, high altitude lakes and reservoirs and in a few small streams. Some remote stream segments may contain a pure strain of the Colorado River cutthroat trout.

The Henry Mountains to the east constitute an isolated and complete ecosystem support a free roaming herd of bison.

The proposed transmission system would pass through some wildlife habitat presently isolated from human use. Wildlife species such as desert bighorn sheep, desert tortoise, Gila monster, southern bald eagle and peregrine falcon require isolation for their survival. It would cross or pass by crucial habitat for the above mentioned species plus mule deer, pronghorn antelope, elk, turkey, Gambel's quail, Abert's squirrel, waterfowl and shore birds.

Proposed transmission corridors include habitats occupied by the following endangered species: black-footed ferret, brown pelican, southern bald eagles, peregrine falcon, Vegas Valley leopard frog, Moapa dace, woundfin, Colorado River squawfish, Gila topminnow, humnback chub, bonytail chub, Colorado cutthroat trout, and possibly other, as yet unidentified species.

The limestone quarry site supports most of the same terrestrial wildlife found on the plateau impact area. In addition, the area supports sage grouse and a few elk. The endangered Utah prairie dog occurs throughout Johns Valley with some colonies within half a mile of the proposed quarry area.

Ecological interrelationships

The Kaiparowits Plateau impact area has been disturbed by man-related activities since early pioneering days. The area was heavily grazed by cattle and sheep from the early days of settlement through the 1940's. Mineral exploration, which started in the 1950's and is still continuing, has also caused changes from the conditions that existed in pre-pioneer days.

Climate more than any other single variable is the overriding force that molds the biological character of the Kaiparowits area. Precipitation is scant and erratic, summers are hot, and the evaporation rate is high. Steep rock slopes cause much of the precipitation to run off without becoming available to plants or animals. Consequently, the area is comprised of plants and animals well adapted for survival in a harsh, arid environment. Even for the well adapted species, existence is often precarious. Populations of both plants and animals fluctuate considerably from year to year in response to climatic variations when the average moisture pattern is barely sufficient for plant growth. A slight variation in amount or seasonal occurrence of precipitation can cause drastic changes. This in turn triggers changes in the population of many species of animal life.

Soils and vegetation, with climate, affect the distribution of plants and animals. The Deep Plateau Soil Association on high benches, including the Fourmile Bench, is the most productive soil type. The Deep Plateau supports grassland, pinyon-juniper and brush, and is seasonally inhabited by deer. The

Shallow Plateau Soil Association on low benches is less productive. Its plant communities are similar to but not as vigorous as their counterparts on deeper soils. The Sandy Soil Association on East Clark Bench receives less rainfall, but is as productive as shallow soils since most rainfall is available for plant growth.

Cattle and big game animals compete for limited forage. The portion of total forage actually usable for some animals is controlled by the limited number of springs, seeps, and small streams. All large mammals of the area require water at least some of the time. Therefore, the few existing sources of water are crucial to populations of big game animals.

Major bays on Lake Powell, including those at the mouths of streams which lead into the impact area, serve as spawning waters and nursery areas for young fish. Since this type of habitat is extremely limited in the lake, the shallow water bays are extremely important to the maintenance of a viable fishery in Lake Powell.

Most productive ecosystems along the proposed transmission line are those having multi-level vegetation or free water (water available for direct consumption by animals). These areas include riparian vegetation as well as the chaparral and pinyon-juniper types. These ecosystems also have the most diverse fauna.

The limestone quarry impact area in Johns Valley has also been disturbed by man related activities. Homesteading activity that lead to plowing and cropping of previously unworked land and overgrazing of other lands was a detrimental influence. Since the end of farming and the beginning of range improvement practices, the habitat of Johns Valley is slowly improving.

Paleontology, archaeology, and history

Fossil vertebrates are relatively abundant in the Kaiparowits formation, which is exposed at the proposed plant site. Such fossils are relatively more sparse in the underlying Wahweap sandstone.

The Indian prehistory covers approximately 12,000 years. Inclusive is a chronological transisition from nomadic big game to small game hunting and wild plant gathering and processing (Desert Culture Tradition) to a sedentary, agriculture-based life style (Anasazi). A return to the nomadic hunting and gathering tradition is apparent with the transitional prehistoric-historic Indian groups.

Detailed archaeological reconnaissance of less than 10 percent of the impact area identified more than 600 archaeological sites. This included seven different types of sites, plus pictographs and petroglyphs. A diversity of prehistoric resources in the area is reflected by variation in site types, distribution, and cultural affiliations.

Historical Indian groups in the region include the Southern Paiute, Navajo, and Hopi. They were in the area from 1100-1300 A.D. until recently.

There are about 35 non-Indian historical sites in the Kaiparowits Plateau impact area, representing explorational, agricultural, and mining efforts in the 18th and 19th centuries.

The Kaiparowits Plateau impact area does not contain any listings on the National Register of Historic Places.

The transmission system impact area includes 13 geologic formations known to contain vertebrate fossils. The unconsolidated sediments and lake beds of the California desert include some of North America's most significant vertebrate fossil areas.

The transmission system would cross numerous prehistoric culture areas, principally Anasazi, Desert, San Dieguito-Lake Mohave, and Pinto-Amargosa cultures. Ages of these cultures range from approximately 12,000 B.C. to the historic contact period. While an intensive archaeological survey has been conducted on only a small part of the system, the results, plus probable sensitivity studies, suggest that sites in the path of the proposed system are likely to number in the hundreds. Many of these sites would undoubtedly qualify for inclusion on the National Register of Historic Places. The proposed Kaiparowits to Phoenix transmission line would pass through two archaeological districts that have been nominated to the National Register of Historic Places. It would also pass within 1 mile of another nominated district.

Historic Indians resident in the impact area include Navajo, Hopi, Pima, Maricopa, Papago, Hualapai, Havasupai, Havapai, Mohave, Paiute, Chemehuevi, Cahuilla, Serrano (Morongo), Vanyume, Luiseno, and Cupeno (Agua Caliente). Reservations which would be crossed by the proposed transmission corridors are Navajo, Navajo-Hopi disputed area, Hualapai, Kaibab, Morongo and Agua Caliente.

Non-Indian historic features in this area include historically significant trails, routes and roads, mining camps, a stage station, and the largest training area ever established by the U.S. Army.

Limestone at the proposed quarry site was deposited by an ancient lake and is essentially devoid of fossils. A total of 18 archaeological sites of six different types have been located within the limestone quarry impact area. Additional sites undoubtedly exist. The limestone quarry impact area does not contain any listings on the National Register of Historic Places.

Recreation

Cultural values in the Kaiparowits Plateau impact area include prehistoric remains, the old Paria townsite, portions of the Escalante and Navajo trails, movie props, and Glen Canyon Dam.

Natural values in this remote area are relatively undisturbed. Many recreational activities are directly or indirectly related to inherent natural values of the surrounding territory. The geology of the region, featuring many formations and unusual rock shapes caused by centuries of erosion, contributes greatly to visitor enjoyment and the recreation potential of the area. Steep-sided canyon walls in multicolored layers, plateaus, and escarpments provide recreational values for the sightseer or photographer.

Primitive and wilderness values are important in the plateau impact area.

Primitive or roadless areas within the plateau impact area that have significant values includes Paria Canyon, Hackberry Canyon, Escalante River Canyon, Fiftymile Mountain, and much of the undeveloped land within Glen Canyon National Recreation Area surrounding Lake Powell. The more accessible portions of the Kaiparowits Plateau impact area are interlaced with numerous low quality roads and trails. These roads and trails have made it a popular place for "back country" exploring with off-road vehicles.

The plateau impact area is in the heart of the "golden circle" of parks. Within the "golden circle" are 15 national parks, monuments, and recreation areas, nine units of the national forest, and millions of acres of highly scenic lands managed by Bureau of Land Management (BLM) or the Navajo Tribal Council. The area is one of the most scenic sections of the country,

attracting millions of tourists annually. Grand Canyon, Rainbow Bridge, Zion, Bryce Canyon, Glen Canyon, and Monument Valley are well known for their scenic beauty. The high visibility enabling persons to see long distances (20 to more than 100 miles) is of paramount importance to enjoyment of this beauty.

The location of the proposed Kaiparowits power plant is 15 miles from the Glen Canyon National Recreation area that encompasses Lake Powell. Important recreational activities in this vicinity besides the normal sightseeing of tourists includes fishing, boating, back-country exploring, camping, picnicing, rock and artifact collecting, and hunting.

The transmission system impact area includes archaeological sites, historic trails, old ranches, mining areas, other historic sites, Indian reservations, modern cultural developments, national forests, and recreation and natural areas. Outstanding scenery, unusual vegetation, and desert bighorn sheep are characteristic of parts of the area. Some sites in the proposed corridors are under consideration for roadless or natural area designation.

Wildlife observation and hunting are the primary recreational activities in the vicinity of the proposed limestone quarry.

Land use

Most of the Kaiparowits Plateau impact area is public land administered by BLM, U.S. Forest Service, or the National Park Service. Most of the land is managed for multiple use.

Nineteen licensees are authorized to utilize 8,053 animal unit months on allotments in the proposed generating plant, mine, or new town areas. Oil is produced in the Upper Valley field near Escalante, and sand and gravel are mined in 12 or more pits near Glen Canyon City, Escalante, and Henrieville. The gathering of wood for burning and for fence posts is carried out mostly on and

near Fourmile Bench. The only current agricultural production in the Kaiparowits impact area is on private land along the Paria River, 13 miles west of Glen Canyon City

Two all-weather highways cross the northern and sourthern edges of the impact area. The impact area can be reached by bus and plane. Parts of the Kaiparowits Plateau impact area are inaccessible, although the area is traversed by approximately 446 miles of four-wheel drive trails and gravel-surfaced or unimproved roads.

Most of the proposed transmission system crosses undeveloped, open range land. Some areas of residential development occur in western California. Rural areas in Utah, Arizona, and Nevada are used mainly for livestock grazing and recreation. "Open space" recreation is the prime use in California. Mineral development and gathering of wood are minor. Agricultural lands would be crossed only in California. The proposed route would cross numerous existing systems including transmission and telephone lines, natural gas and water pipelines, a coal slurry pipeline, highways and roads. The lines would also pass near several airports and airstrips.

Cattle grazing, sand and gravel quarrying, some recreation use, and several miles of roads are major land uses in the limestone quarry impact area. Several hundred acres of alfalfa and grain near the proposed quarry site are irrigated by water from a spring to the south.

Land use planning

Three major land use plans have been or are being prepared for the Kaiparowits Plateau impact area. These are the Kane County Master Plan, the BLM Management Framework Plan for the Paria planning unit, and the National

Park Service Master Plan for the Glen Canyon National Recreation Area. All three plans suggest management policies and proposals and consider potential energy development in a general sense.

Most of the land within the proposed transmission system impact area is rural. County zoning and planning are not specific with regard to future transmission lines. Master or land use planning has not been conducted for much of this area. Some of the routes proposed for federal lands fall within general corridors identified in Bureau of Land Management and U.S. Forest Service planning efforts.

The proposed limestone quarry is on both National Forest land and land owned by the State of Utah. The U.S. Forest Service multiple-use management plan, completed in 1965, is being revised in 1975 in compliance with the National Environmental Policy Act.

<u>Socioeconomic factors</u>

Census records indicate the areas of Kane and Garfield Counties within the Kaiparowits Plateau impact area had a total population of 3,229 in 1970. The population is declining.

Unemployment in Kane and Garfield counties is the highest in Utah even though their general educational level is above the national median. The decline of agricultural employment and the seasonal nature of many jobs contribute to unemployment.

Services are adequate for the present population and basic commercial facilities are generally available. The physical facilities of public schools within a 60 mile radius of the proposed project are more than adequate for their present student population.

Kanab, located approximately 40 road miles west of the proposed plant site, is the largest community within Kane County. The population was 1,381 in 1970. The community is located on Highway 89 between Phoenix and Salt Lake City. Tourist trade has been important in the local economy since the town is readily accessible to vacationers visiting Southern Utah's many attractions. In addition, Kanab has served as a temporary base for movie companies who use the picturesque Utah scenery as background for their movies.

Most of the residents in the plateau impact area have ancestors who were involved in the early Mormon colonization of this area. Social patterns such as family and extended family unity, emphasis on formal education, relatively low major crime rates, respect for local political and religious officials, a commitment towards work and employment, and a sense of aesthetic appreciation, pervade in the culture of these residents. The historical and social characteristics which give impact area residents and communities their unique identity, make this kind of community vulnerable to disorganization when social changes occur.

Glen Canyon City is composed of mobile homes in various conditions of upkeep. There are no sidewalks, lawns, paved streets, or public recreational facilities in the community. Public services are severely limited. This is not to convey that some residents may not be contented and/or optimistic about the future prospects for their community.

Page, Arizona, located about 47 road miles southeast of the proposed plant site, is the largest community within the immediate plateau area. This community was founded in 1956, as a federal city owned by the Bureau of Reclamation, to serve as a construction base for Glen Canyon Dam. Recently it has also served as a construction base for the nearby Navajo power plant. The April

1975 population was 7259 but available documentary information shows the population is declining. The expected January 1976 population is 5750. Page was incorporated under Arizona state law in 1975.

The proposed transmission system area is sparsely populated except the area in and around Phoenix, parts of western California, and the Las Vegas area. The population has generally been increasing in Arizona, California, and Nevada Standard Metropolitan Statistical Area (SMSA) urban centers. The percentage of unemployed persons in these same urban centers is generally less than in nearby rural counties. Proposed routes would cross Indian reservations where residents such as Navajo, Hopi, Haulapai, Morongo and Agua Caliente have unique life styles and aspirations. These residents particularly, are environmentally conscious and profess through their religious values a concern for preserving their environment.

Farms, ranches and communities in the limestone quarry impact area share the cultural and sociological characteristics mentioned for all other Utah communities in the Kaiparowits Plateau impact area: a vulnerability to disorganization if large technological change activities occur in their immediate areas.

Probable future environment without project (trends)

If energy resources in the Kaiparowits impact area are not used, current natural processes and conditions within the area would continue with little alteration, because of little change in resident population. Recreational use may increase, depending on gasoline availability. The city of Page, Arizona, would decline in population to about half its 1972 size.

Approximately 220,800 acres of land in and near the Kaiparowits Plateau are currently under coal lease, prospecting permit, or competitive lease applications. If coal mines, other than those proposed by the applicants, were to be developed to produce 12 million tons of coal annually, 3,000 to 4,000 miners would be employed. This suggests a population increase of as much as 15,000 in the area, with commensurate requirements for resources.

If a 2,000 megawatt generating plant were built near Escalante, using 8 million tons of coal annually, 24,000 to 30,000 acre-feet of water would be required. About 4,000 acres of land would be occupied, and the population of Garfield County would increase by 3,000 to 5,000 people. Impacts would be somewhat different from those resulting from the Kaiparowits proposal because of the different location.

EXISTING ENVIRONMENT

Climate

Kaiparowits Plateau impact area

Climate of the Kaiparowits Plateau impact area is arid to semiarid with considerable geographic, seasonal and annual variation.

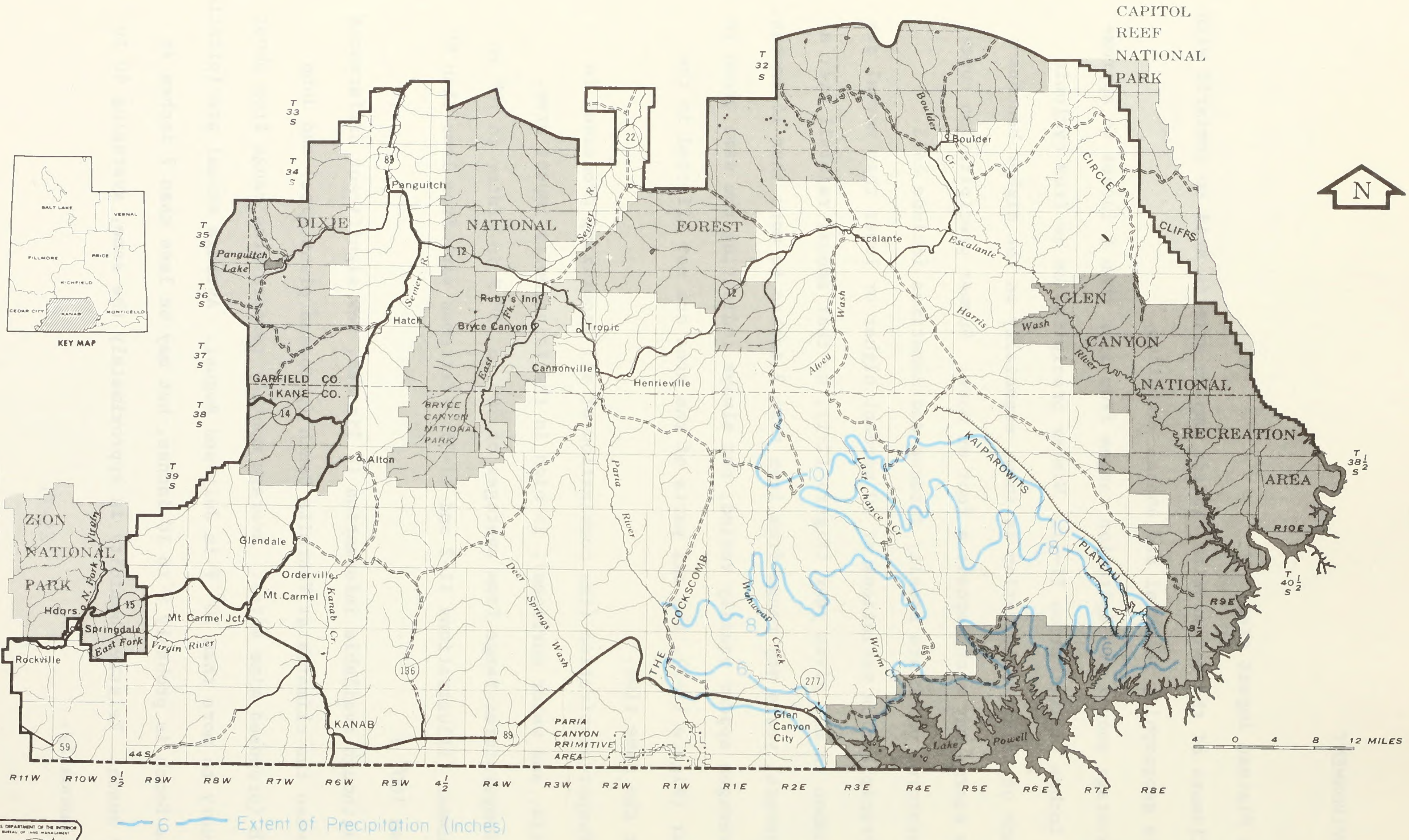
Average annual precipitation ranges from less than 6 inches to approximately 10 inches (Illustration II-1). Winter precipitation is from cyclonic storms. Much of this precipitation is snow, especially on the higher benches where a few storms may each deposit a foot or more. Summer precipitation comes from thunderstorms which are usually intense and sometimes include hail.

Precipitation variations of 50 percent higher or lower than normal are probably common in any given year (Figure II-1), so that annual rainfall over a period of several years may range from less than 3 inches to more than 15 inches. Seasonal averages appear equally varied, not always indicating the same trend in a given year (Figure II-2), and all parts of the area are not affected in the same way at the same time.

Evapotranspiration (the combination of all vaporizing processes in plants, soils, and water surfaces), is high in the Kaiparowits impact area.

Temperatures range from averages of 30° to 35° F in winter to 70° to 80° F in summer (Illustrations II-2 and II-3). Extremes vary from less than 0° to more than 100° F.

Although available information is limited, few significant differences appear between the climates at Fourmile Bench (proposed plant site) and John Henry Bench (proposed mine site). Average monthly temperatures range from about 30° in January to more than 70° F in July and August. Average annual precipitation at Fourmile Bench is probably 9 to 10 inches, but may be less than 7 inches at John Henry Bench. Relative humidity is approximately the same, averaging 40 to 50 percent annually.



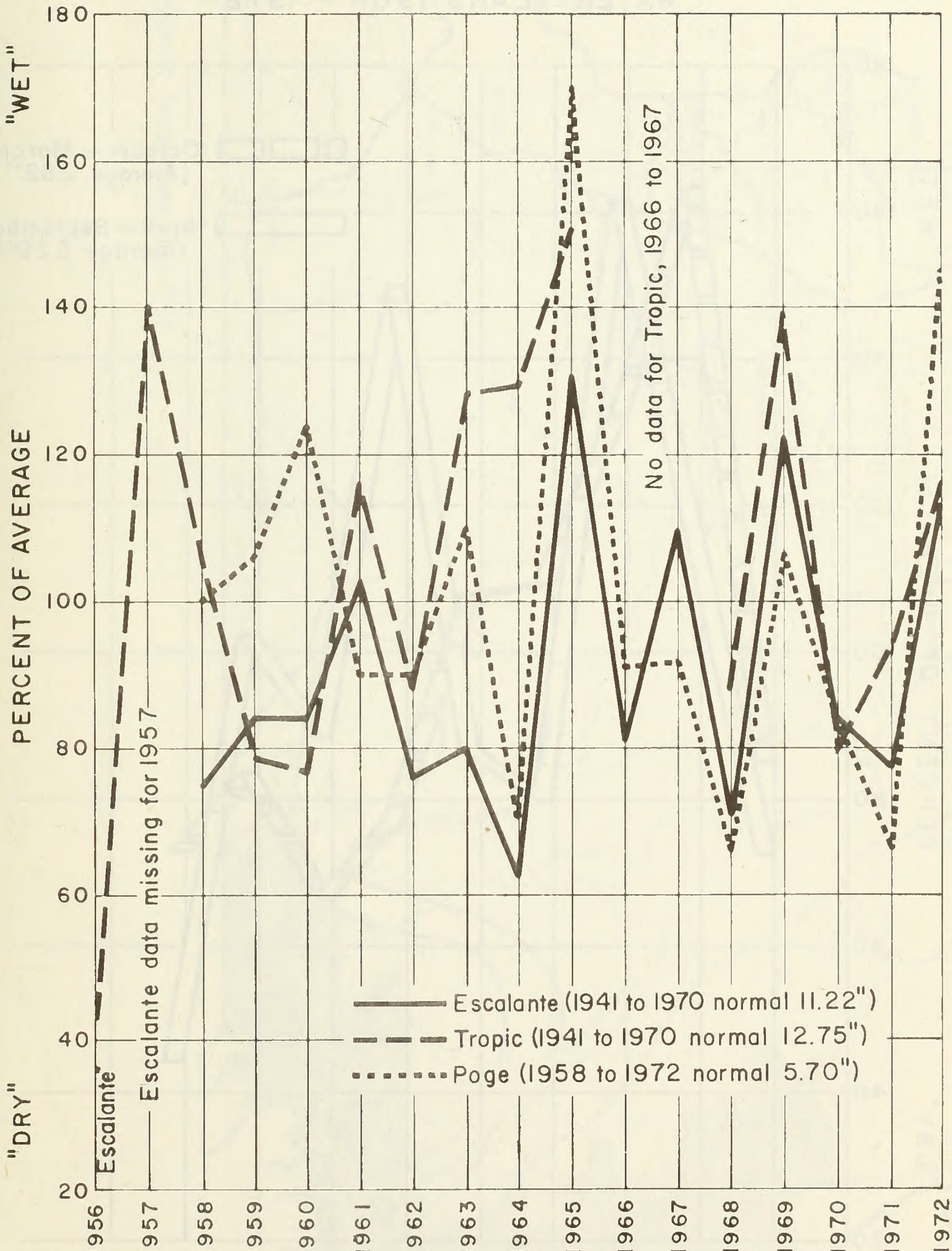
KANAB DISTRICT
1974
UTAH

ILLUSTRATION II-1

Estimated Annual Average Precipitation

FIGURE II-1

Percent Normal Annual Precipitation at Selected Stations



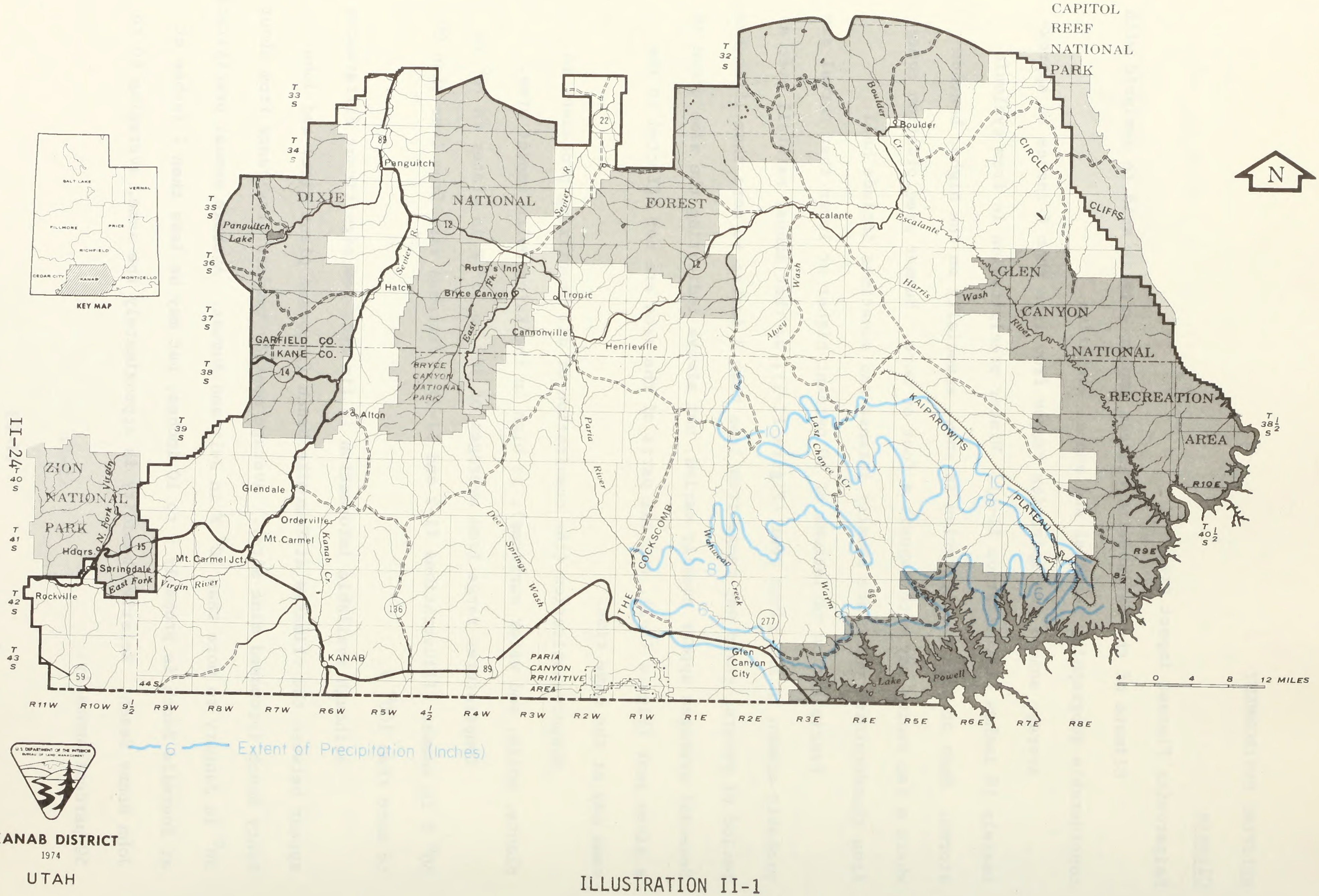


ILLUSTRATION II-1

Estimated Annual Average Precipitation

FIGURE II-1
Percent Normal Annual Precipitation at Selected Stations

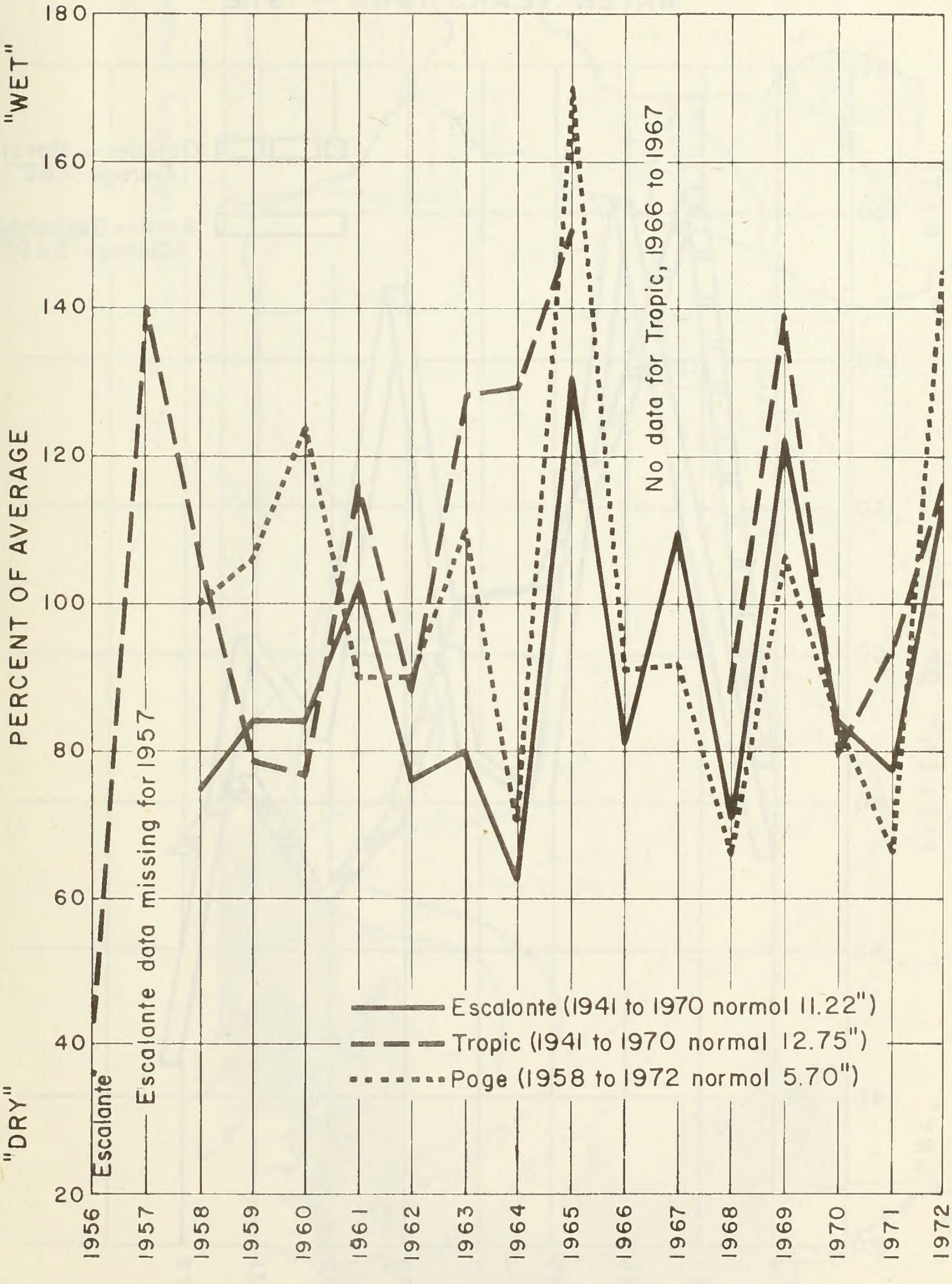
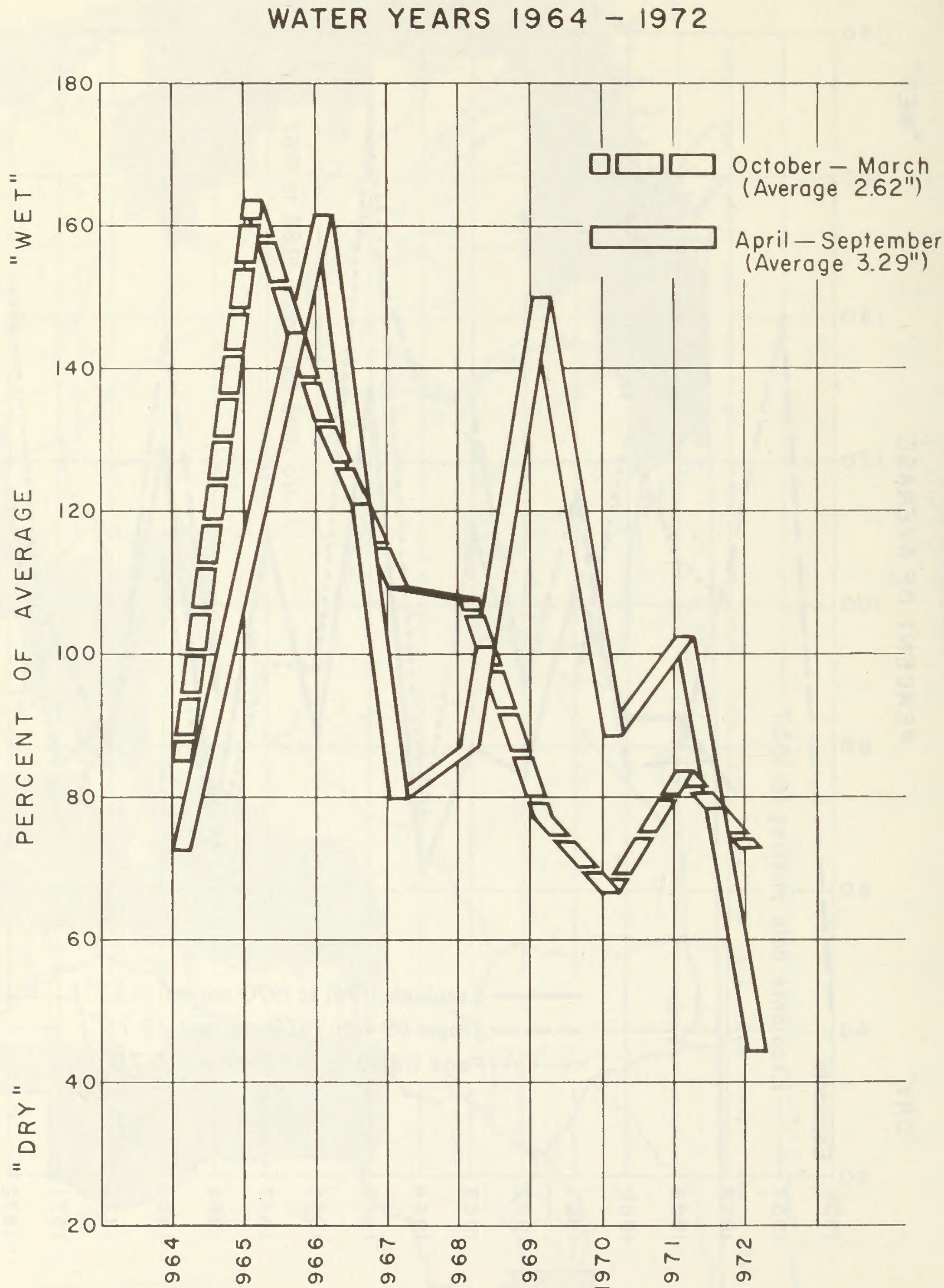
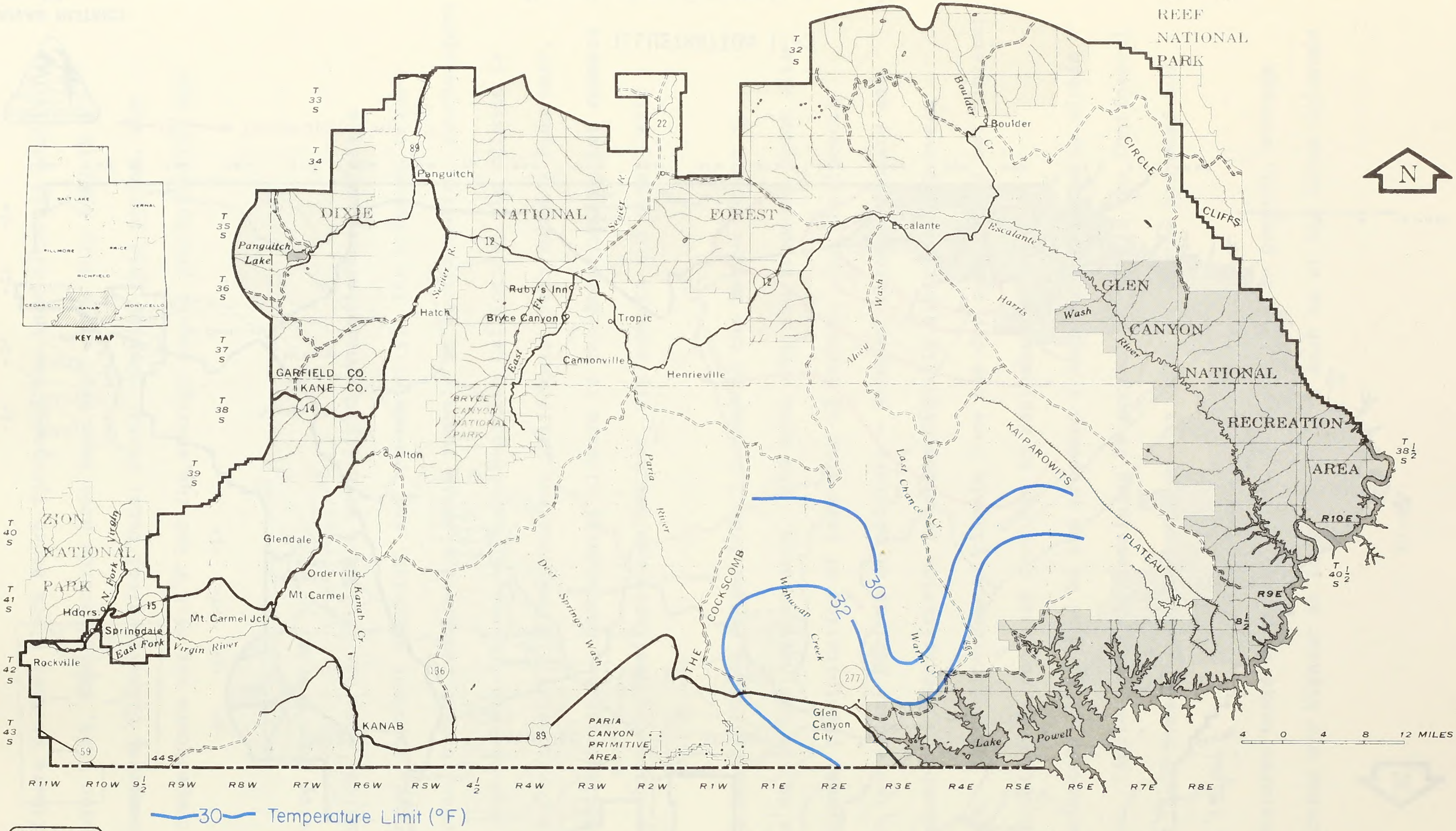


FIGURE II-2

Seasonal Variation in Precipitation at Glen Canyon City, Utah





U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

KANAB DISTRICT
1974
UTAH

ILLUSTRATION II-2

Mean Surface Temperature - January

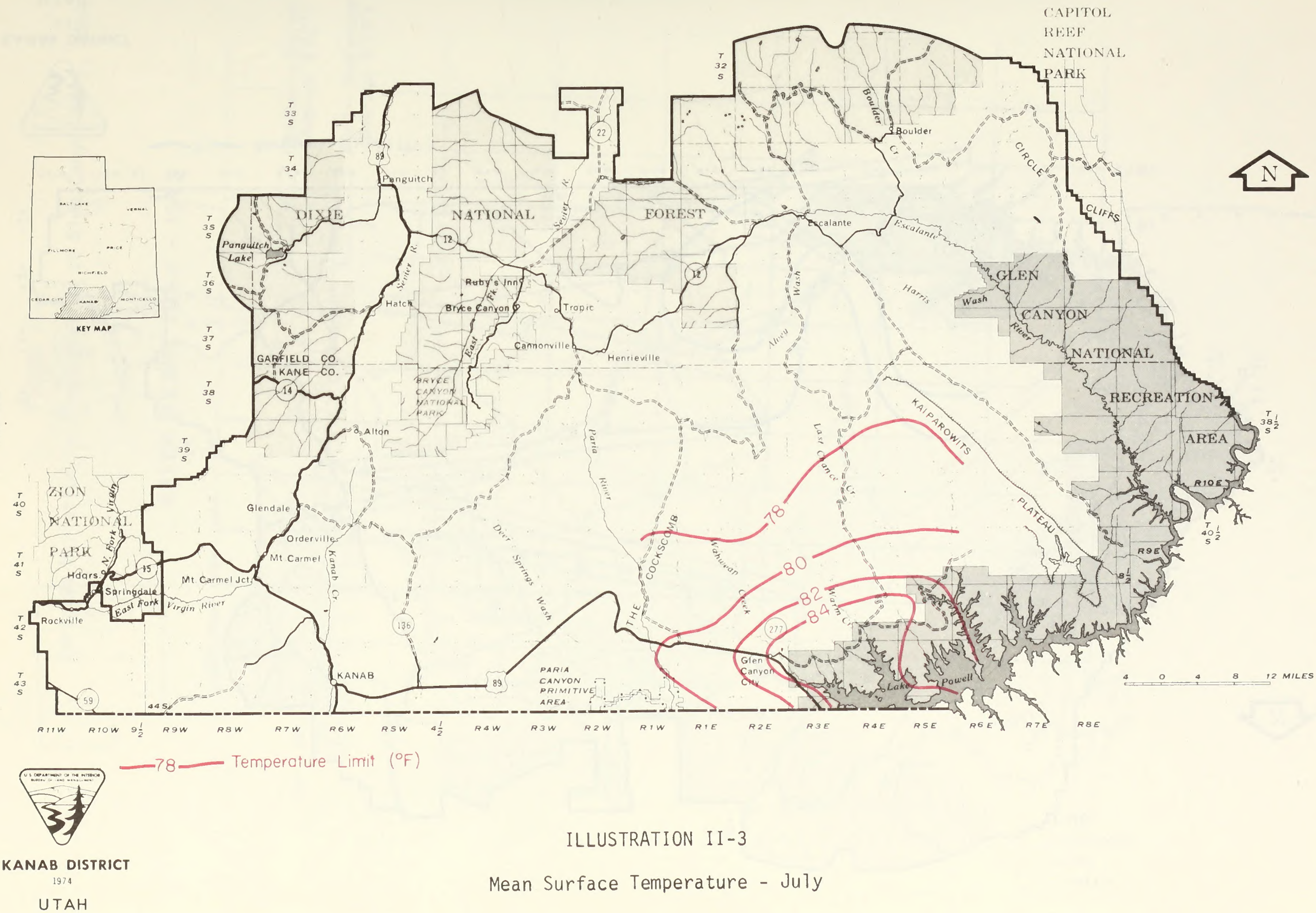


ILLUSTRATION II-3

Mean Surface Temperature - July

The climate at East Clark Bench (proposed new town site) is similar to that of Glen Canyon City, where records have been kept since July 1962 (U.S. Department of Commerce, Climatological Data: Utah). During this period, the average annual temperature was 56.8°F and the average annual precipitation was 6.29 inches.

Transmission system impact area

Most of the area has a climate with light precipitation, moderate temperature changes, abundant sunshine, and low humidity. The proposed transmission routes pass through two broad climate zones: in southern Utah, southeastern Nevada, central and western Arizona, and southeastern California, the climate is arid to semiarid Continental; in southwestern California, from Banning Pass west, the climate is Mediterranean. Continental climate is characterized by hot summers and mild winters while the Mediterranean has hot, dry summers and moist, mild winters.

Annual precipitation ranges from 3 inches in the Mohave Desert to nearly 20 inches in the Los Angeles area. The area near the proposed plant site has an average annual precipitation of less than 12 inches. The Continental climate zone has two annual periods of moisture - November through January and July through September. Precipitation is almost equally distributed between these two periods. The Mediterranean climate zone has dry summers and wet winters; almost no precipitation is recorded from May to September.

Approximately 11 percent of the proposed transmission system is within the Mediterranean climate zone; the remaining 89 percent is within the Continental climatic zone. These percentages are based on the location of the proposed 500 kV transmission lines.

Temperatures range from below 0° to over 100° F. In general, average monthly temperatures are highest at lower elevations such as at the Lower Colorado

River, Coachella Valley, and Salt River Valley at Phoenix. High temperatures in these regions range from 90° to 120° F for 6 months of the year. High elevations in Arizona and Utah have cooler temperatures, ranging from 80° to 90° F in summer, to 30° F and below in winter.

Extreme high summer temperatures combined with the high rate of evapotranspiration greatly reduces the efficiency of limited moisture to sustain life over much of the transmission system impact area.

Winds are extremely variable over most of the area. Average velocity ranges from 8 to 10 miles per hour (mi/h) however, velocities over 70 mi/h have been reported at most observation stations in the area.

Limestone quarry impact area

The Bryce Canyon Federal Aviation Administration (FAA) airport weather station is the nearest source of climatic data for the area. This station is located 10 miles south of the proposed quarry site and at approximately the same altitude, so recorded data are reasonably representative of conditions at the proposed quarry site. According to these records, average monthly precipitation ranges from 0.5 inches in January to 1.7 inches in August (Figure II-3), and average annual precipitation varies from 12 to 16 inches (Illustration II-4).

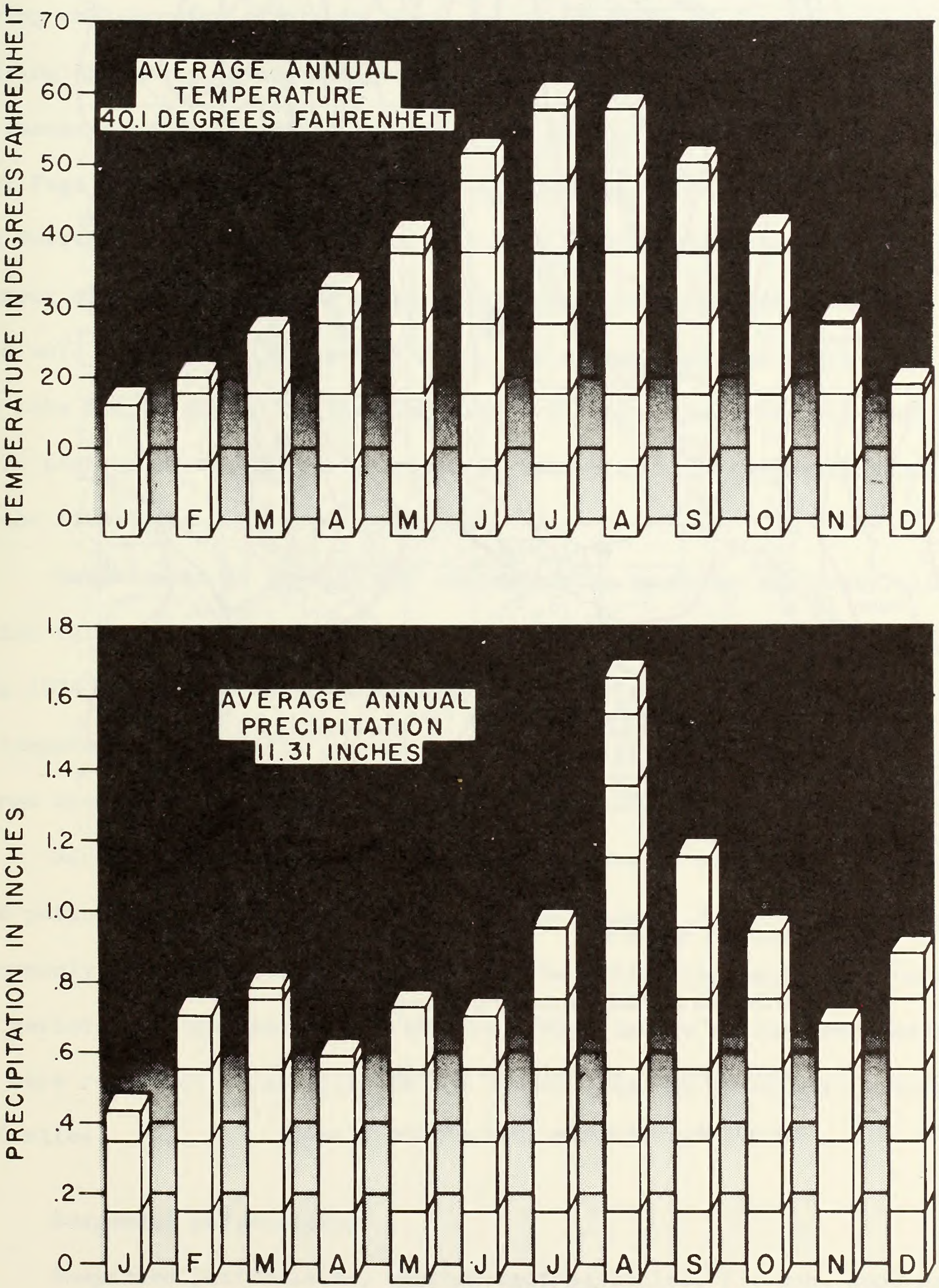
Average monthly temperatures recorded at the Bryce Canyon station from 1949 to 1973 ranged from 18.9° F in January to 62.1° F in July. In this area, midwinter daytime temperatures often remain below freezing and midsummer temperatures often exceed 90° F.

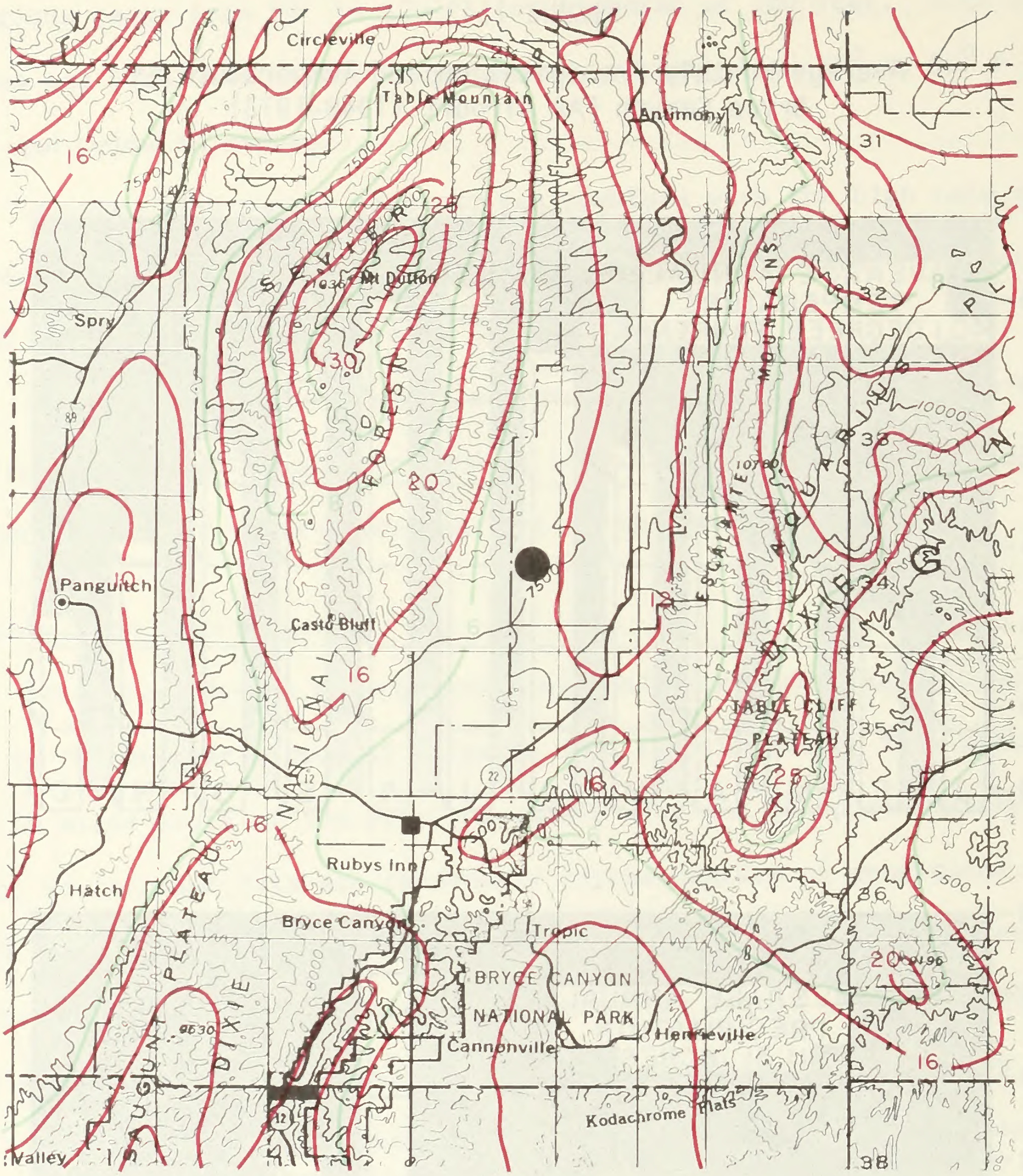
No wind data are available for the proposed quarry area, but topographic conditions favor an easterly flow of near-surface air toward Johns Valley.

With sufficient precipitation, evapotranspiration would average approximately 35 inches a year, based on the Braney-Criddle determination method and temperature records collected at the Bryce Canyon FAA airport station (Cruff and Thomson, 1967).

FIGURE II-3

Average Monthly Precipitation and Temperature at Bryce Canyon FAA Airport (1948-1973)





Proposed quarry site

Bryce Canyon FAA Airport climatologic station

12 Normal annual precipitation in inches

6 Normal May—September precipitation in inches

ILLUSTRATION II-4

Normal Annual and Normal May - September Precipitation in Vicinity of Proposed Limestone Quarry

Air quality

Kaiparowits Plateau impact area

Existing air quality

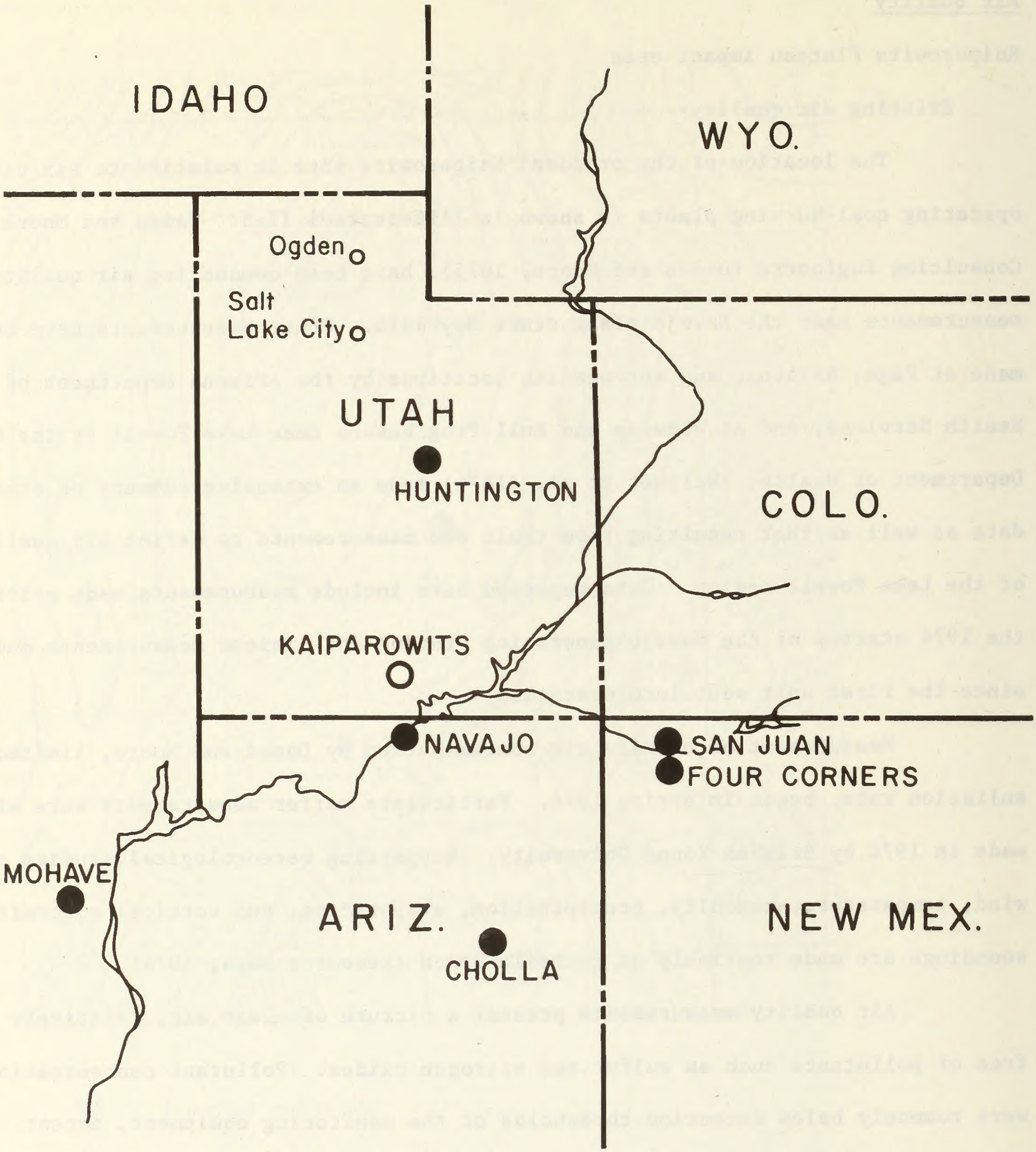
The location of the proposed Kaiparowits site in relation to six other operating coal-burning plants is shown in Illustration II-5. Dames and Moore Consulting Engineers (Dames and Moore, 1975), have been conducting air quality measurements near the Navajo plant since May 1970. Other measurements have been made at Page, Arizona, and surrounding locations by the Arizona Department of Health Services, and at Wahweap and Bull Frog basins near Lake Powell by the Utah Department of Health. Walther et al. (1974) made an extensive summary of other data as well as that resulting from their own measurements to define air quality of the Lake Powell region. Data reported here include measurements made prior to the 1974 startup of the Navajo generating station and limited measurements made since the first unit went into operation.

Measurement of on-site air contamination by Dames and Moore, limited to sulfation rate, began in spring 1974. Particulate matter measurements were also made in 1974 by Brigham Young University. Supporting meteorological studies of wind, temperature, humidity, precipitation, evaporation, and vertical aircraft soundings are made routinely at Fourmile Bench (Resource Data, 1974).

Air quality measurements present a picture of clean air, relatively free of pollutants such as sulfur and nitrogen oxides. Pollutant concentrations were commonly below detection thresholds of the monitoring equipment, except during periods of high winds when relatively high levels of suspended particulate matter were recorded. Visibility in the impact area was excellent, averaging over 70 miles.

Suspended particulates

Suspended particulates, whether soil particles, fly ash, soot particles, water droplets, or ammonium nitrate-sulfate particles, increase light scattering



(Source: Modified from Joint Meteorological Report, Sep 1974)

ILLUSTRATION II-5

Relative Locations of Six Major Fossil Fuel-Burning Power Plants and Proposed Kaiparowits Plant

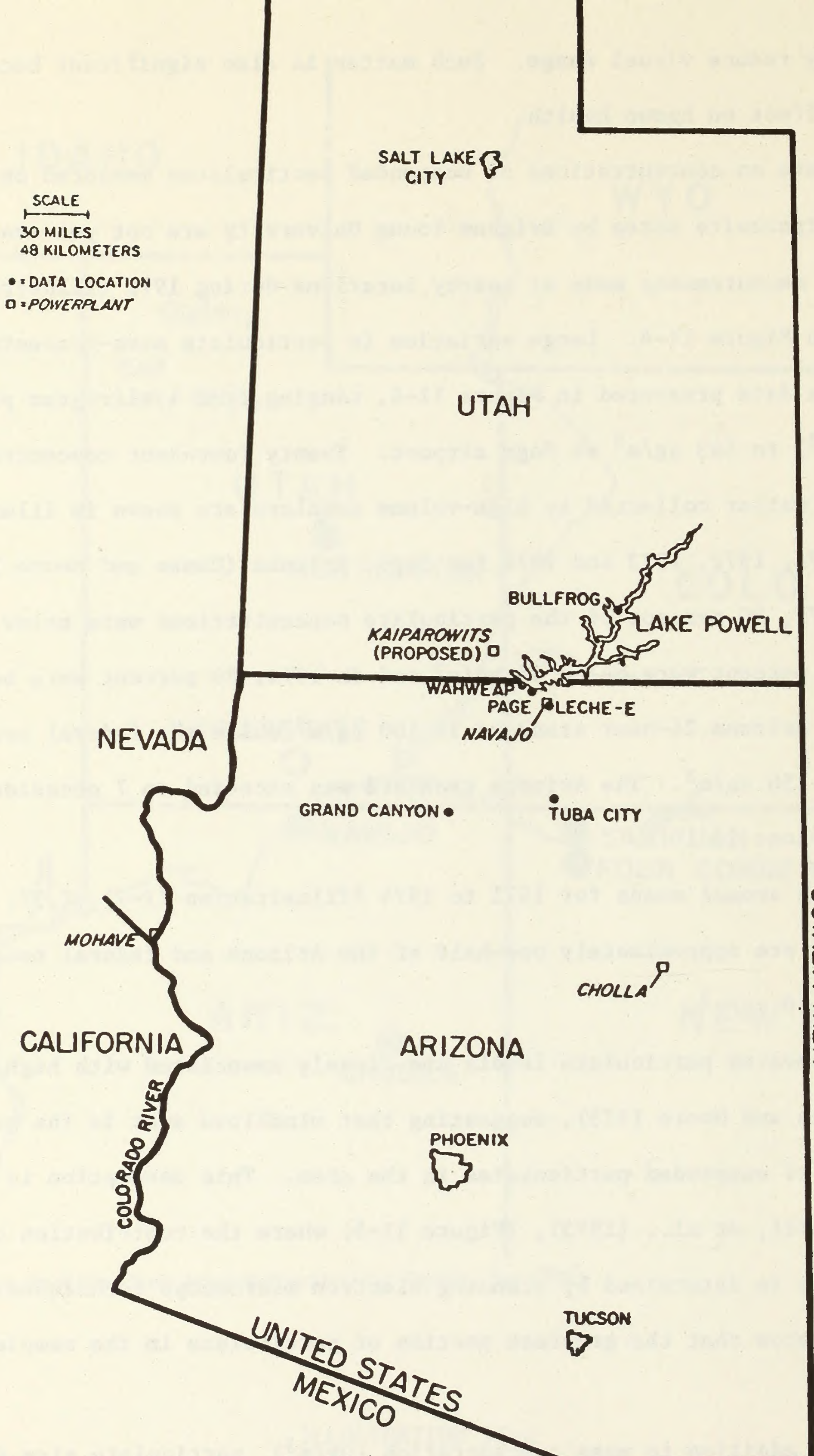
and thus may reduce visual range. Such matter is also significant because of the potential effect on human health.

Data on concentrations of suspended particulates measured on the proposed Kaiparowits sites by Brigham Young University are not yet available. Particulate measurements made at nearby locations during 1972 (Illustration II-6) are shown in Figure II-4. Large variation in particulate mass-concentration can be seen from data presented in Figure II-4, ranging from 1 microgram per cubic meter ($\mu g/m^3$) to 543 $\mu g/m^3$ at Page airport. Twenty four-hour concentrations of particulate matter collected by high-volume samplers are shown in Illustration II-7 for 1971, 1972, 1973 and 1974 for Page, Arizona (Dames and Moore 1975). In 1971 and 1972, 80 percent of the particulate concentrations were below 58 $\mu g/m^3$; in 1973, 80 percent were below 45 $\mu g/m^3$ and in 1974, 80 percent were below 65 $\mu g/m^3$. The Arizona 24-hour standard is 100 $\mu g/m^3$ while the federal secondary standard is 150 $\mu g/m^3$. The Arizona standard was exceeded on 7 occasions in 1973, and 27 occasions in 1974.

The annual means for 1971 to 1974 (Illustration II-7) of 33, 29, 27, and 38 $\mu g/m^3$ are approximately one-half of the Arizona and federal secondary standard of 60 $\mu g/m^3$.

Elevated particulate levels are closely associated with high wind speeds (Dames and Moore 1975), suggesting that windblown dust is the greatest contributor of suspended particulates in the area. This assumption is supported by data of Hill, et al., (1973), (Figure II-5) where the contribution of each particle type is determined by scanning electron microscope techniques. Data in Figure II-5 show that the greatest portion of particulate in the sample was soil dust.

In addition to mass concentration ($\mu g/m^3$), particulate size distribution and number concentration observations were made in the impact area. Detailed



(Illustration from Walther, et al., 1974)

ILLUSTRATION II-6

Index Map of Locations of Particulate Matter Sampling

FIGURE II-4

Mass Concentration of Particulates for Six Locations in Northern Arizona and Southern Utah (1972)

Location	Quarter in 1972	Concentration (micrograms per cubic meter) Minimum	Median	Geometric Mean	Arithmetic Mean	Maximum	Source
Leche-e	Jan - Mar	15	37	33	37	73	EPA[a]
	Apr - Jun	18	36	36	39	73	EPA
	Jul - Sep	29	41	--	--	78	EPA
Page Airport	Jan - Mar	-- (6)[b]	--	--	--	-- (543)	--- (D&M)[b]
	Apr - Jun	--(13)	--	--	--	-- (319)	--- (D&M)
	Jul - Sep	29(11)	46	49	55	145 (220)	EPA (D&M)
	Oct - Dec	11 (1)	22	22	24	48 (76)	EPA (D&M)
Tuba City	Jan - Mar	44	56	62	67	133	EPA
	Apr - Jun	26	47	49	53	89	EPA
	Jul - Sep	41	70	--	--	137	EPA
Grand Canyon	Jul - Sep	10	15	--	--	27	ASDHS[c]
	Oct - Dec	7	9	9	10	12	ASDHS
Wahweap	Jan - Mar	3	--	32	42	184	USDH[d]
	Apr - Jun	9	--	31	44	226	USDH
	Jul - Sep	16	--	41	52	339	USDH
	Oct - Dec	5	--	10	11	39	USDH
Bullfrog	Jan - Mar	3	--	19	27	186	USDH
	Apr - Jun	9	--	30	43	600	USDH
	Jul - Sep	4	--	30	37	126	USDH
	Oct - Dec	4	--	10	13	122	USDH

[a] EPA = Environmental Protection Agency;

[b] Values in parentheses measured by D&M = Dames & Moore

[c] ASDHS = Arizona State Department of Health Services

[d] USDH = Utah State Department of Health

SOURCE: Taken in part from Walther et al. 1974.

(Source: Dames and Moore, 1975)

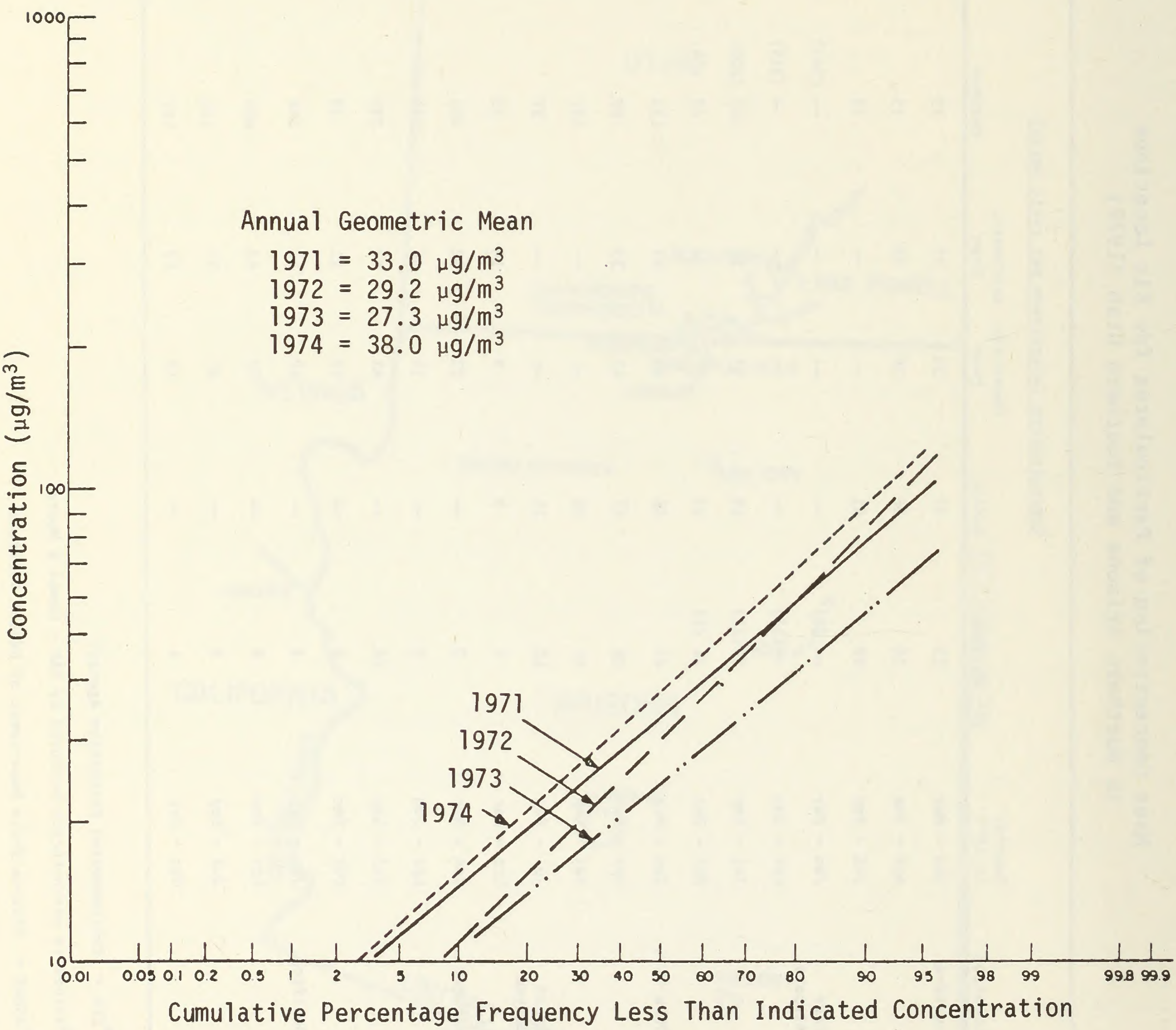


ILLUSTRATION II-7

Cumulative Frequency Distribution of Particulate Concentrations
(Collected on High Volume Sampler)

FIGURE II-5

Short Period Particulate Concentrations in Grand Canyon and Near Page, Arizona

Suspended Particulate	Particulate Concentration ($\mu g/m^3$)						
	Indian Gardens Campground (19-20 Feb 72)	Phantom Ranch (15-20 May 72) (average)	Page, Ariz. (12-14 Sep 72)	Glen Canyon City (3-4 Oct 72)	Glen Canyon Dam (12-13 Oct 72)	Page, Ariz. (27-28 Dec 72)	Wahweap (15-16 Feb 73)
	Total						
Fly Ash	0.43	0.30	0.072	0.053	0.36	0.77	0.23
Soil Dust	10.46	18.63	33.61	115.19	18.86	56.78	4.70
Sulfate type	0.21	0.04	0.034	0.03	0.55	0.07	1.00
Soot	-	-	0.006	0.005	0.021	0.28	0.072
Total	11.1	18.97	33.72	115.27	19.79	57.9	6.00
	Less Than 2 microns/diameter						
Fly Ash	0.16	0.08	0.006	0.003	0.36	0.77	0.046
Soil Dust	1.15	1.30	1.03	1.79	1.33	5.06	0.27
Sulfate type	0.21	0.04	0.034	0.03	0.55	0.07	0.89
Soot	-	-	0.004	0.004	0.018	0.25	0.06
Total	1.52	1.42	1.07	1.83	2.26	6.15	1.27

Data from Hill, et al (1973)

measurements were made at Page, using a cascade impactor and a high volume segregator (Dames and Moore, 1975), to separate particles from sampled air into size components. These measurements indicated that the mass median diameter (MMD) of the aerosol at Page for 1971, 1972, 1973, and 1974 averaged about 3 micrometers (μm). These values are somewhat greater than the MMD measured in most urban areas (typically less than 1 μm), but are similar to those measured by the University of Utah at various locations in the southwestern United States (Hill et al., 1973 a, 1973 b.).

Fine particulates are those in the range of 0.003 to 1.0 μm. Fine-particulate concentration, given as the number of condensation nuclei (CN) per cubic centimeter (cm^3), can reflect the air quality of a region. A CN concentration of 1,000/cm^3 or lower is normally found only in very clean areas. The concentration range of 1,000 to 5,000/cm^3 is considered to have a low pollution level. Concentrations from 5,000 to 50,000/cm^3 are considered to have moderate air pollution and concentrations in excess of 50,000/cm^3 are commonly present in badly-polluted air.

Measurements of fine-particle concentrations have been made at Page and elsewhere in the impact area for varying periods during 1972 and 1973 (Walther et al., 1974, Schaefer, 1973). The CN concentrations in northern Arizona and southern Utah ranged from 1,000 to 11,000/cm^3 with nearly 70 percent of the recorded observations in the "low" air pollution category. Measurements in downtown Page in 1973 showed a mean number concentration of about 16,000/cm^3 while measurements at remote locations near Page showed a concentration of about 1,500/cm^3. Higher concentrations in Page no doubt result from urban activity, especially auto exhausts.

Sulfur dioxide

Sulfur dioxide (SO_2) measurements have been continuous at Page since May 1970 (Dames and Moore, 1975), using the colorimetric method of West and Gaeke

(1956). The 24-hour average concentrations have not exceeded minimum detectable limits (0.01 parts per million) in measurements between 1970 and 1974. Continuous conductimetric measurements at Page ranged between 0.01 and 0.032 parts per million (ppm) for mean daily maximum 1-hour SO_2 concentrations, from 1970 to 1972, with a slight increase during the period (Figure II-6). The highest daily maximum 3-hour SO_2 concentration recorded in 1973 was 0.015 ppm (Figure II-7), only 3 percent of the federal ambient air quality standard of 0.5 ppm (1300 $\mu g/m^3$). The highest 3-hour concentration recorded in 1974 was 0.026 ppm which was only 5.2 percent of the state and federal standard but does show an increase from 1973 to 1974.

Seven-day measurements of SO_2 were made at Fourmile Bench from July 1974 to February 1974 using a Reizner permeation device. The weekly values ranged between 0 and 28.9 $\mu g/m^3$ (0-.01 ppm). No attempt was made to equate the values to national air quality standards except to indicate that the values were low (Dames and Moore 1975).

Sulfation-rate measurements with lead peroxide cylinders are an indirect method of measuring SO_2 concentrations. However, the measurements are important because the concentration is so low in the Lake Powell area that it is frequently unmeasureable by more direct methods (Walther et al., 1974). Sulfation rates were low at 19 locations in Utah and Arizona from 1970 to 1973. Data for three of the stations near the Lake Powell area are shown in Figure II-8. Measurements at Bullfrog and Wahweap by the Utah Division of Health are also included. Levels range between 0.004 and 0.150 milligrams per 100 square centimeters per day ($mg/100\ cm^2/day$). In contrast, some American cities range from a few tenths of a milligram to 9 $mg/100\ cm^2/day$ (Tabor and Golden, 1965). Sulfation rates at Page and Wahweap show a general increase in 1974 over 1973. Sulfation rates measured at Nipple Bench between December 1973 and September 1974 ranged between .002 $mg/100\ cm^2/day$ and .022 $mg/100\ cm^2/day$ (Dames and Moore 1975).

FIGURE II-6

Mean Daily Maximum One-Hour SO_2 Concentrations
Page, Arizona

Concentration (ppm)	Cumulative Percent Less Than Indicated Concentrations		
	5/15/70-12/31/70	1971	1972
.010	100.0	41.8	61.0
.012		59.1	72.5
.014		76.1	82.9
.016		82.8	89.4
.018		86.5	92.7
.020		94.0	93.4
.022		96.0	94.1
.024		97.5	94.6
.026		98.5	95.2
.028		99.5	95.2
.030		100.0	99.4
.032			100.0

NOTE: Calculations by Conductimetric Method

From Dames and Moore, 1974.

FIGURE II-7

Mean Daily Maximum 3-Hour SO_2 Concentrations, Page, Arizona (Conductimetric Method)

Concentration Parts Per Million	Cumulative Percent Less Than Indicated Concentration 1973	1974
.01	97.7	81.5
.011	97.9	83.1
.012	98.8	89.7
.013	98.8	91.3
.014	99.7	92.3
.015	100.00	92.3
.016		95.9
.017		96.4
.018		96.4
.019		96.4
.020		96.9
.021		96.9
.022		97.9
.023		99.0
.024		99.0
.025		99.5
.026		100.0

Dames and Moore, 1975.

FIGURE II-8

Sulfation Rates Measured at Three Locations in the Lake Powell Region

Location	Rates ($mg/100\ cm^2/day$)													
	Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Annual[a]	Jan-Sep[a]
Bullfrog	1970														
	1971					.011						.009			
	1972	.006		.008		.012		.010		.012		.014		.044	
	1973	.026		.019		.012		.010		.011		.017			.061
Page, AZ	1970								.060	.030	.080	.000	.030		
	1971	.110	.010		.004		.005						.013		
	1972		.016		.006		.030		.010		.005		.016		
	1973		.017		.021		.014		.013		.015		.020		
	1974		.020		.025		.020		.040		.027		.023		
Wahweap	1970								.030	.030	.010	.010	.070		
	1971	.130	.010		.033		.009						.018		
	1972		.013		.009		.010		.012		.008		.017	.069	
	1973		.017		.026		.012		.013		.015		.020		.150
	1974		.027		.022		.020		.028		.023		.027		

[a]Arithmetic mean from Utah State Division of Health data

Data taken from Dames and Moore, 1975, and Walther E. C. et al., 1974.

The SO_2 measurements made at Page by the Arizona Bureau of Air Quality Control (Figure II-9) also show an annual average increase from .0004 ppm in 1973 to .003 ppm in 1974, with 24-hour maximum concentration increases from .004 ppm in 1973 to .008 ppm in 1974. The first 750 megawatt (MW) unit of the Navajo generating station began operation in February, 1974, and the second 750 MW unit in December, 1974, with commercial production in June, 1974, and April, 1975, respectively.

Nitrogen oxides

Nitrogen oxides have been measured at Page since 1970, as 24-hour average concentrations (Dames and Moore, 1974). Data previously reported in the draft impact statement were determined by the Jacobs-Hochheiser method of analysis, which has been shown to be unreliable (Dames and Moore 1975), and have not been considered in this final statement. Measurements made by the Arizona Bureau of Air Quality Control are shown in Figure II-9. Measured levels of nitrogen dioxide (NO_2) have shown an increase from 0.005 ppm (10 $\mu g/m^3$) in 1973 to 0.012 ppm (24 $\mu g/m^3$) in 1974 at Page. Maximum 24-hour concentrations show an increase from 0.024 to 0.066 ppm. The state and federal ambient air quality standard for NO_2 is an annual average of 100 $\mu g/m^3$.

Oxidants

Oxidant concentrations have been measured at Page since July 1970, using only the Haagen-Smit method until 1971, adding an automatic coulometric method in 1972, and the standard Environmental Protection Agency (EPA) approved reference method in May 1972 (Dames and Moore, 1974). The major oxidant, especially in relatively clean air, is ozone, most of which is naturally generated in the upper atmosphere by solar radiation. Global background concentrations of ozone generally range between 0.015 and 0.030 ppm (Stern 1968). Monthly average

FIGURE II-9

Concentration of Total Suspended Particulates (TSP), Sulfur Dioxide (SO_2) and Nitrogen Oxides (NO_x) Measured at Page, Arizona

Pollutant	Year	Concentration ($\mu g/m^3$)	Concentration (ppm)
Total Suspended Particulates	[a]1969	17	
	1970-1971	Insufficient Data	
	1972	31	
	1973	52	
	1974	48	
Sulfur Dioxide	[b]1973	1	.0004
	24-hour max	11	.004
	1974	8	.003
	24-hour max	22	.008
Nitrogen Oxide	[b]1973	10	.005
	24-hour max	49	.024
	1974	24	.012
	24-hour max	132	.066

[a]Annual geometric mean

[b]Annual arithmetic mean

Data from Bureau of Air Quality Control, Arizona Department of Health Services

measurements at Page ranged between 0.011 and 0.037 ppm for 1971 and 1972, with spring maximums evident in 1971 and 1972 measurements (Walther et al., 1974). The maximum 1-hour average concentration measured was 0.043 ppm in 1972 which exceeded the Arizona 1-hour standard for photochemical oxidants. The standard was not exceeded in 1973 but was exceeded 12 times in 1974. The Arizona standard for a peak concentration of 0.075 ppm and the national ambient air quality maximum 1-hour standard of 0.08 ppm were not exceeded.

Trace elements

Trace elements are those that appear in nature in relatively minute amounts, many of which take an active part in important biological processes. Others such as beryllium, mercury, lead, arsenic, cadmium, fluorine, and selenium, are potentially hazardous to living organisms, including man, when present in sufficient quantities. Adverse environmental effects of abnormally high concentrations of trace elements include the action as catalysts in formation of secondary air pollutants, and their corrosiveness, causing economic loss. Because coal is the product of ancient biological activity, it contains small quantities of many of these elements, the variety and concentration of which depend upon the nature of the coal bed formation. Results of analyses of coal samples from the Kaiparowits area are shown in Figure II-10. Results represent five independent core sample trace element analyses, using different techniques. The range of values, mean and standard deviation of the Kaiparowits samples, and typical concentration in coal samples from deposits around the world are shown in Figure II-10. Concentrations found in Kaiparowits coal are generally well within expected range, and most are in the lower portion of the range. Combustion can release these materials to the ecosystem. Trace elements in the atmosphere have been measured at Page by the Arizona Department of Health since 1969. Results are summarized in Figure II-11. Concentrations of nitrate and sulfate, which are

FIGURE II-10

Concentrations of Trace Elements Found in Coal and Ash of Kaiparowits Coal and Concentrations From Deposits Around the World

Trace Element		Concentration (ppm) Kaiparowits Coal APS[a]	Kaiparowits Coal SWES[b]	Kaiparowits Ash SWES[b]	World Wide[c] Coal	World Wide[c] Ash
Antimony	Sb		.13 ± .07		10 - 30	
Arsenic	As	.83 ± .81	.90 ± .20		0.8 - 500	
Barium	Ba			2290 ± 2055		18 - 2200
Beryllium	Be	.48 ± .19		3.40 ± 3.30		1 - 4000
Boron	B			1400 ± 834		52 - 10,000
Cadmium	Cd	.87 ± .73		0.7 ± 0.7		No data
Cerium	Ce		BLD			No data
Chromium	Cr	3.6 ±2.3		62 ± 11		0.1 - 7,400
Cobalt	Co			12 ± 10		5 - 2,000
Copper	Cu			80 ± 11		10 - 1,200
Fluorine	F	54 ± 42	120 ± 23		40 - 480	
Gallium	Ga			26 ± 5		10 - 3,200
Germanium	Ge		BLD			9 - 47,000
Lanthanium	La		BLD			30 - 700
Lead	Pb			38 ± 11		200 - 31,000
Lithium	Li			72 ± 26		No data
Manganese	Mn	6 ± 2		210 ± 164		100 - 22,000
Mercury	Hg	.06 ± .07	.04 ± .01		.001 - 300	
Molybdenum	Mo			6 ± 3		5 - 6,000
Nickel	Ni	5 ± 1		34 ± 21		
Selenium	Se	4 ± 4	1.98 ± .58			No data
Strontium	Sr			560 ± 261		0 - 1,000+
Scandium	Sc			14 ± 2	No data	60 - 400
Tellurium	Te		.02	.34 ± .12		No data
Thallium	Tl			3,000 ± 1		100 - 35,000
Titanium	Ti		.66 ± .36		0 - 24,000	
Uranium	U	8 ± 1		92 ± 35		10 - 25,000
Vanadium	V			44 ± 24		10 - 2,000
Yitrium	Y			4 ± 1		No data
Ytterbium	Yb			64 ± 70		115 - 21,000
Zinc	Zn			150 ± 1		0 - 7,000
Zirconium	Zr					

[a]APS - Data supplied to Arizona Public Service.

[b]SWES - Southwest Energy Study, Report of Coal Resources

[c]Hearings before Committee on Interior and Insular Affairs, U.S. Senate, U.S. Government Printing Office, Vol. I, p 19 (May 1971).

FIGURE II-11

Annual Average Concentration of Trace Element Measurements at Page Arizona (1969 through 1974)

Constituent	Concentration ($\mu g/m^3$)		
	1969-72[a]	1973	1974
Sulfate	1.40	3.50	3.50
Nitrate	0.60	0.70	NA
Zinc	0.90	0.03	0.05
Iron	0.30	0.50	0.60
Benzene Soluble Organics	1.20	0.70	1.50
Copper	0.13	0.06	0.10
Lead	0.08	0.10	0.20
Manganese	0.01	0.01	NA
Nickel	0.004	NA	NA
Bismuth	0.005	NA	NA
Cobalt	0.002	0.003	NA
Chromium	0.004	<0.001	NA
Cadmium	0.001	0.001	NA
Mercury	0	<0.001	NA
Arsenic	0.002	NA	NA
Tin	0.010	NA	NA
Titanium	0	NA	NA
Vanadium	0	NA	NA
Total Aerosols[b]	16		

[a]Arithmetic mean of annual arithmetic mean concentrations available from 1969 through 1972.

[b]Geometric mean of annual geometric means.

NA - Not analyzed.

(Walther, et al., 1974, and Bureau of Air Quality Control, Arizona Department of Health Services 1975).

oxidation products of nitric oxide and sulfur dioxide respectively, are produced by coal combustion as well as other combustion sources. The concentrations of these two aerosols are low. Source of the benzene-soluble organics (Figure II-11) is primarily automobile emission, in part reflecting urban activity at Page. Other elements are not easily related to a single source. Concentrations in Figure II-11 reflect relatively low levels. Additional measurements are being made at Fourmile and Nipple Bench by Brigham Young University but data are not yet available.

Radioactive nuclides

Radioactivity in air can be in gaseous or particulate form, and can include transient residue from local or worldwide fallout from nuclear testing and effluents, such as krypton, xenon and tritium, from nuclear-power reactors and fuel reprocessing plants. Radioactivity is also omnipresent in air from natural emitters, primarily decay products of uranium and thorium.

Measurements of total beta activity of particulates, collected by high-volume samplers at Page by the Arizona Department of Health, were taken in 1969 but the program was suspended because the measurement levels were low. No measurements are presently being made of atmospheric radioactivity in the Page or Lake Powell areas.

Power plant emissions would contain small amounts of radium, thorium, and radioactive elements resulting from their decay. The radioactive nuclides would be associated primarily with fly ash (Eisenbud and Petrow, 1964). An analysis of coal to be used at the Kaiparowits plant (Figure II-25) reveals the presence of 0.17 picocuries per gram (pCi/g) thorium-232, 0.18 pCi/g radium-228, 0.29 pCi/g thorium-230 and 0.13 pCi/g radium-226, for a total activity concentration of 0.77 pCi/g.

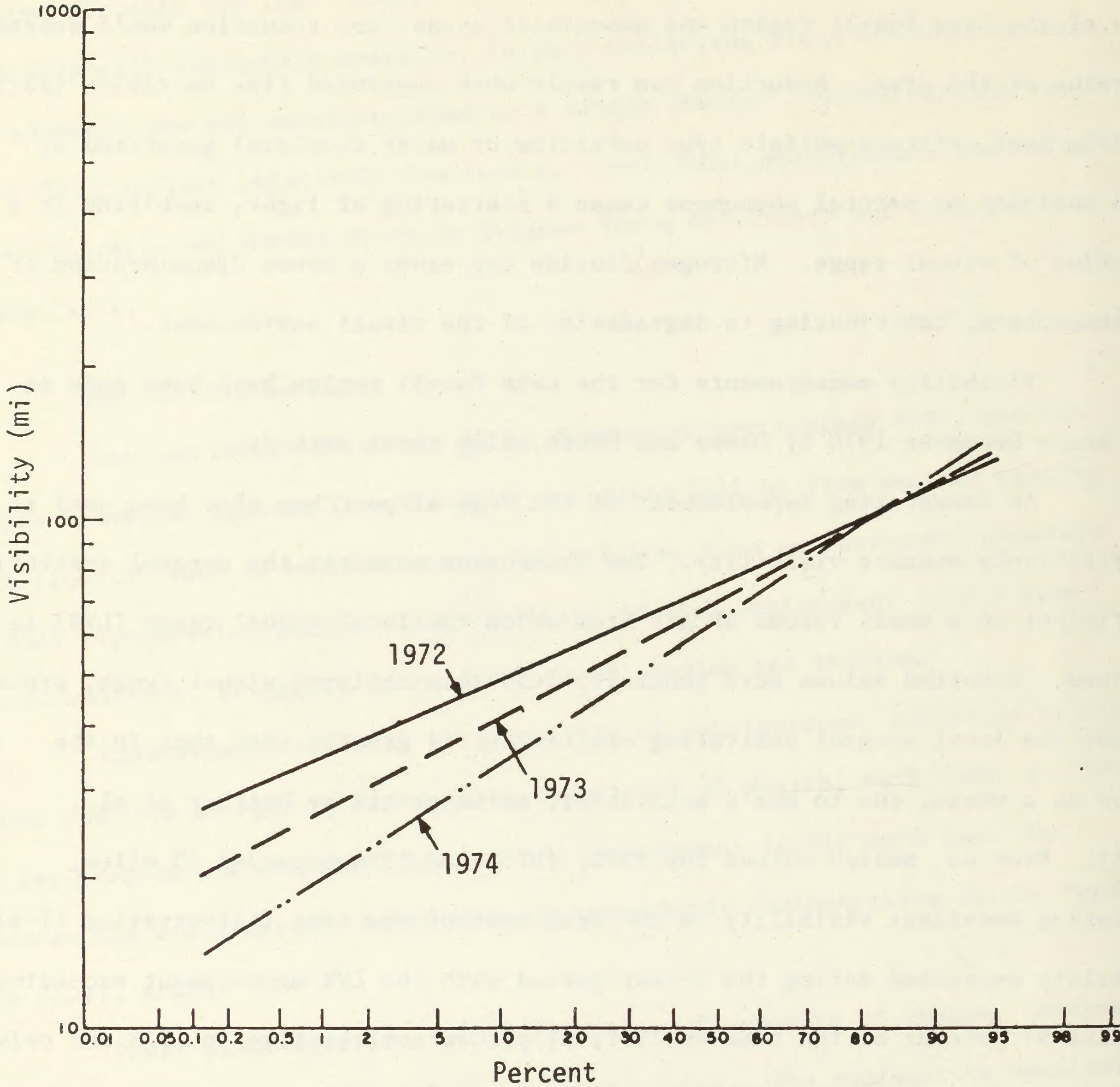
Visibility

Restricted visibility is the most immediately observable effect of air quality degradation. Visibility is crucial to the aesthetic and recreational value of the Lake Powell region and associated areas, and reduction would degrade the value of the area. Reduction can result when suspended fine particles (soil, fly ash, soot, nitrate-sulfate type particles or water droplets) generated by human activity or natural phenomena cause a scattering of light, resulting in a reduction of visual range. Nitrogen dioxide can cause a brown discoloration of the atmosphere, contributing to degradation of the visual environment.

Visibility measurements for the Lake Powell region have been made at Page since December 1970 by Dames and Moore using three methods.

An integrating nephelometer at the Page airport has also been used to quantitatively measure visibility. The instrument measures the aerosol scattering coefficient in a small volume of air from which the local visual range (LVR) is obtained. Reported values were generally less than regional visual range, probably because the local aerosol scattering coefficient is greater than that in the region as a whole, due to man's activities, as suggested by Walther et al., (1974). Even so, median values for 1972, 1973, and 1974 exceeded 60 miles, indicating excellent visibility in the area most of the time (Illustration II-8). Visibility decreased during the 3-year period with the LVR measurement exceeding 40 miles 97 percent of the time in 1972, 91 percent of the time in 1973 and only 80 percent of the time in 1974 (Dames and Moore 1975). Figure II-12 shows the number of days on which the LVR was less than 30 miles for 15 minutes or more. The data show a greater occurrence in both 1973 and 1974 over 1972.

Long path measurements of regional visibility were made by Dames and Moore using a camera and telescope, giving a quantitative value, shown in Figure II-13. The annual means of visual range dropped slightly during the 3-year



(Source: Dames and Moore, 1975)

ILLUSTRATION II-8

Cumulative Frequency Distribution of 2-Hour Average Values of Visual Range
(Measured by Nephelometer)

FIGURE II-12

Number Days Local Visual Range Less Than 30 Miles
(15 Minutes or More)

	1972	1973	1974
JAN	1	6	13
FEB		11	7
MAR	7	4	6
APR	8	11	5
MAY	10	14	3
JUN	5	15	8
JUL	13	21	11
AUG	12	24	4
SEP	9	11	5
OCT	8	12	11
NOV	9	15	25
DEC	2	10	16
ANNUAL	84	154	114

Dames and Moore (1975)

FIGURE II-13

Yearly Summary of Visual Ranges, Page, Arizona

Year	Visual Range (mi)			
	Mean	Median	[a]Mode	[b]5-Percentile
1972	80	78	60-70	34
1973	75	73	60-70	49
1974	72	70	60-70	35

[a]Mode: The interval of most frequent occurrence.

[b]5-Percentile: That value above which fall 95 percent of the measurements.

Data from Dames and Moore (1975)

monitoring at Page, from 80 miles in 1972 to 72 miles in 1974. During each of the 3 years most frequent visual ranges measured were between 60 and 70 miles.

The third method used to estimate regional visual range is the viewing of distant objects from Page airport. Objects included Bryce Canyon (60-65 miles), Monday Canyon (30 miles) and Navajo Mountain (30 miles). Although subjective, such observations can provide a valuable record. Results will not be detailed but they supplement other visibility measurements discussed above.

The plume from the Navajo plant (the plant began operation in February of 1974), has been observed periodically. It can be expected that the influence of this new source on visibility in the Lake Powell region will be greatest during the fall and winter because of higher relative humidity and more limited dispersion conditions. According to Dames and Moore (1975), "if the meteorological parameters which affect visibility remained constant during the past 4 years, one would expect a decrease in visibility due to increased particulates. Since the meteorological parameters do not remain constant, the changes in visibility caused by increased particulates could be completely masked. This appears to be the case in 1974."

A yellow discoloration, associated with the Navajo plant has frequently been observed as either a ribbon extending downwind from the plant stacks or as a more generalized distribution with broader horizontal dispersion. The frequency of occurrence, meteorological condition under which it appears, extent of distribution, and influence on visibility have not been documented.

Coal fires have burned along outcrops in a number of areas throughout the Kaiparowits Plateau (Speltz and McCann, 1974). Seven fire areas are now burning in the Smoky Mountain area within 10 miles of the proposed site. No quantitative or qualitative measurements have been made of the effluent from these fires but the smoke and gas produced are periodically observable.

Atmospheric dispersion potential

Air quality of any area is strongly influenced by atmospheric dispersion potential of the area. Dispersion is, in turn, a result of wind direction and velocity patterns, and varying atmospheric conditions.

The Kaiparowits site is approximately 25 miles northwest of Lake Powell, 2,000 feet above the level of the lake. Topography surrounding Lake Powell is characterized by complex, irregular terrain, sloping upward in all directions and generally rimmed by 8,000 foot terrain. Approximately 30 miles north of the basin are the Kaiparowits Plateau and Fiftymile Mountains with elevations of 7,000 to 8,000 feet. Navajo Mountain, about 50 miles east-southeast, rises to 10,388 feet and the Kaibab Plateau rises to about 9,000 feet, 70 to 80 miles to the southwest.

There are openings to the basin along the Colorado River drainage between Navajo Mountain and Kaiparowits Plateau on the east and Marble Canyon to the southwest. The San Juan River, with a large valley system including the Four Corners area of northwestern New Mexico, joins the Colorado River about 50 miles east of the proposed site.

It is difficult to generalize concerning the low-level wind patterns of the area because of the irregular terrain and local topographic effects. Surface winds in the vicinity of Lake Powell and influencing the Navajo power plant area exhibit a valley influence with a large percentage of light winds controlled and directed by surface topography and thermal conditions (Van der Hoven et al., 1972). During nighttime hours, a 5 to 7-miles per hour drainage wind generally develops from the south or southeast, persisting for 10 to 12 hours. Daytime surface winds are much more variable in direction and speed, but the general flow is from the southwest.

Irregular terrain in the area of the proposed Kaiparowits site, approximately 2,000 feet above the lake, exerts a pronounced influence on surface

winds. There is a more variable wind flow with less probability of deep nighttime drainage-wind layers occurring. The wind pattern does become more organized with increased altitude, with a predominant flow from the west and southwest.

Throughout most of the year, the average atmospheric transport and mixing characteristics of the region result in good dispersion conditions, particularly during spring and summer. The resultant large-scale transport is toward the northeast (Joint Meteorological Report 1971).

Temperature soundings made from aircraft indicate a large percentage of stable-temperature structure in the atmosphere around Lake Powell much of the time. A year-round, ground-based temperature inversion occurs in the early morning hours approximately 60 percent of the time.

Such low-level atmospheric stability reduces the degree to which pollutants will be mixed in the atmosphere. Seasonal mixing depths in the Lake Powell Basin are shown in the Joint Meteorological Report (1971).

Season	Mean Maximum Mixing Depth (ft) AGL
Winter	3,500
Spring	10,500
Summer	12,500
Fall	7,000

The degree of mixing is seasonally dependent, with summer mixing depths much greater than those of the winter.

Limited dispersion conditions (low mixing depths and low wind speeds) do exist during the colder months of late fall and winter, with an attendant build-up of air pollutant levels. The Joint Meteorological Report states that, "Analysis of frequency and duration of such conditions shows that periods of 5 to 13 days may occur on the average of two to three times per winter (November-February) in the southern portion and four to five times in the northern portion of the Colorado Plateau region. The most frequent duration of these periods is 5 to 7 days, which implies that frontal passages with resultant air mass exchange from higher levels to the ground generally occur at weekly intervals."

The degree to which emissions from a site will be confined by these limited dispersion conditions depends upon the elevation of the site in relation to surrounding terrain, the depth of vertical mixing in the atmosphere, and the height of the stack plume. In addition, the relative elevation of the terrain in relation to height of the plume will determine whether the plume will be transported by local terrain-induced wind effects or by large-scale synoptic wind fields.

Historical meteorological information - particularly data regarding wind velocity and atmospheric stability to be used in assessing air quality and potential impact - is limited for the Kaiparowits site. Meteorological studies have been and are presently being conducted on the proposed power plant site, by the consulting firms of Dames and Moore, and North American Weather Consultants, to supplement other weather information applicable to the site. Meteorological measurements have also been made at Page by Dames and Moore since April, 1970. Such data have been used to define existing environmental conditions and to predict emission impacts from the proposed plant. The data can also be used as a basis for continuing surveillance and monitoring.

Air movement patterns

Surface winds

Measurement of surface winds indicates that irregular terrain in the proposed site area exerts a pronounced influence on low-level wind patterns.

A continuous surface-wind measurement program has been conducted at the proposed Fourmile Bench site since May 1974 (Resource Data, 1974). Because of the short record period, these data were supplemented by measurements made since November 1971 at Nipple Bench (Dames and Moore, 1974) to define low-level wind patterns in the impact area. Nipple Bench is 12 miles south-southeast of Fourmile Bench at a 1,000 foot lower elevation. Surface-wind measurements were made from

November 1971 to December 1974 from a 50-foot tower located on the Nipple Bench site. The annual frequency shows that west is the prevailing wind direction with an average speed of 11.3 miles per hour which is the highest average wind speed of all directions. For those winds with velocities greater than 20 miles per hour, the direction is invariably from the west. Seasonally, winds at Nipple Bench reach highest velocities in spring and early summer with a prevailing westerly direction. Lightest winds are in the fall and winter. Although meteorological information for Fourmile Bench is of much shorter duration, the differences appear insignificant. Annual prevailing direction is west-southwest (compared with west at Nipple Bench) and the mean annual velocity is lower (Dames and Moore 1975).

Upper winds

The winds aloft are important because stack effluents would be emitted to the atmosphere several hundred feet above the ground. Plume rise and subsequent dispersion of stack effluents are, in part, functions of the wind speed at and above the stack top. Wind direction above the stack controls the direction that emissions will follow while dispersing downwind.

Although vertical wind measurements have been made since April 1970 at Page, 32 miles southwest of Fourmile Bench (Dames and Moore 1974), simultaneous measurements at both places have been made only during November 1973 and May 1974 (Spangler et al., 1973, 1974).

At predicted altitudes of plume transport (7,000 to 8,000 feet), however, the winds above Page are sufficiently well correlated by direction and speed that the data accumulated there since April 1970, can be used to analyze plume transport over the Kaiparowits area. In general, the established correlations apply when Page and Fourmile Bench are within the same air mass and not affected by strong meteorological systems such as low pressure systems, fronts, or thunderstorms.

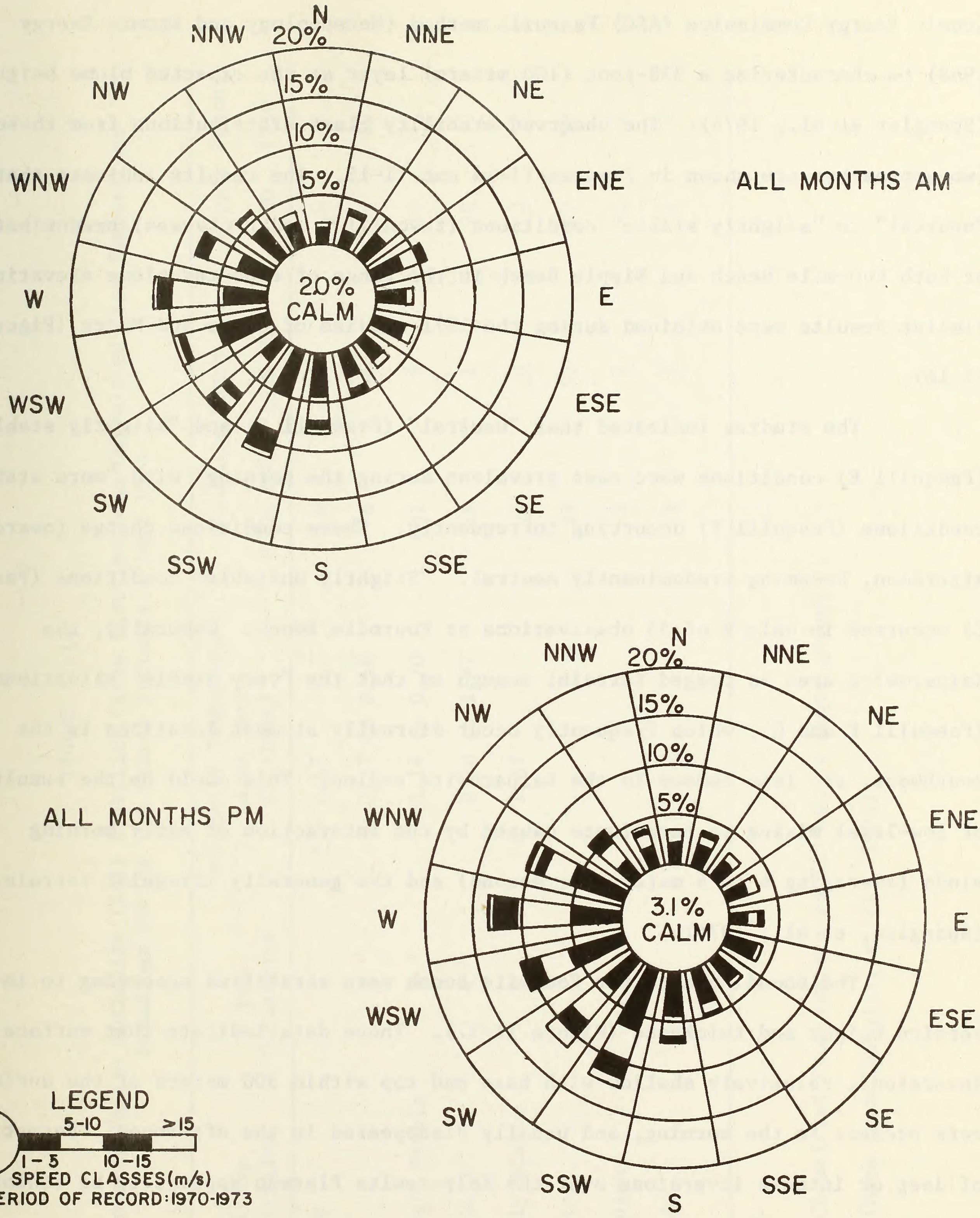
From the long term Page wind data, net air movement over the site was determined to be generally from west and southwest toward the east and northeast, with the most frequent direction from the west. Illustration II-9 is a wind summary of the morning and afternoon soundings from Page, covering the period April 1970 to December 1973, at an elevation of 7,300 feet mean sea level (MSL) (1,200 feet above Fourmile Bench), the altitude of predicted plume transport above the site. Winds are to be expected from the south-southwest to the west-northwest quandrant roughly 50 percent of the time, with winds distributed rather uniformly through the remaining quandrants the rest of the time. A more detailed summary of the upper winds at 7,300 feet is shown in Appendix II-I.

Atmospheric stability and air pollution potential

Stability of the atmosphere plays an important role in dispersion and diffusion of stack emissions. A discussion of atmospheric-stability structures and their influence on stack-emission behavior is presented in Appendix II-2.

To develop information on diffusion patterns at the Fourmile Bench site, a number of field studies were conducted to determine the temperature and plume dispersion structure at and downwind from the site. Techniques included the use of instrumented aircraft to measure vertical temperature gradients, air turbulence, and dispersion of oil smoke plumes and fluorescent particle tracers (Spangler et al., 1973, 1974). Vertical temperature measurements were made above the Nipple Bench site during January, February, October and December, 1971 (Dames and Moore, 1973) and a temperature-sounding program was conducted at the proposed Kaiparowits plant site from February 4, 1974 to January 27, 1975.

The temperature-sounding data collected between February 1974 and June 1974, at Fourmile Bench and Nipple Bench, were used to calculate stability classes using the Tennessee Valley Authority (TVA) method (Montgomery, et al., 1972) to characterize the layer from the surface to 1,073 feet (327 meters), and the



(Dames and Moore, 1973)

ILLUSTRATION II-9

Frequency of Wind Speed and Direction for All Seasons
(Winds at 7,300 Feet MSL Above Page, Arizona)

Atomic Energy Commission (AEC) Pasquill method (Meteorology and Atomic Energy 1968) to characterize a 328-foot (100 meters) layer at the expected plume height (Spangler et al., 1974). The observed stability class distributions from these two approaches are shown in Figures II-14 and II-15. The results indicate that "neutral" to "slightly stable" conditions (Pasquill D and E classes) predominated at both Fourmile Bench and Nipple Bench in the range of expected plume elevations. Similar results were obtained during the 1971 studies of Dames and Moore (Figure II-16).

The studies indicated that "neutral" (Pasquill D) and "slightly stable" (Pasquill E) conditions were most prevalent during the morning, with "more stable" conditions (Pasquill F) occurring infrequently. These conditions change toward afternoon, becoming predominantly neutral. "Slightly unstable" conditions (Pasquill C) occurred in only 2 of 55 observations at Fourmile Bench. Generally, the Kaiparowits area is rugged terrain; enough so that the "very stable" situations (Pasquill F and G), which frequently occur diurnally at most locations in the southwest, are less common in the Kaiparowits region. This could be the result of low-level mixing in turbulence caused by the interaction of early morning winds (averaging 4 to 6 meters per second) and the generally irregular terrain (Spangler, et al., 1974).

The sounding data for Fourmile Bench were stratified according to inversion height and thickness (Figure II-17). These data indicate that surface inversions, relatively shallow with base and top within 300 meters of the surface, were present in the morning, and usually disappeared in the afternoon. Formation of deep or intense inversions over the Kaiparowits Plateau appears to be inhibited by the movement of cooler air down from higher terrain. The 1971 studies at Nipple Bench indicated that during the winter, low-level surface inversions were common, often strong enough to maintain throughout the day. The surface may warm, but not enough to completely remove the inversion. This condition would be

FIGURE II-14

Tennessee Valley Authority (TVA) Stability Class Distributions Calculated from Temperature Soundings During the Period February - June 1974

Stability Classification	TVA Categories	Potential Temperature Lapse Rate ($^{o}C/100m$)	Fourmile Bench 0730 MST	Fourmile Bench 1330 MST	Nipple Bench 0730	Nipple Bench 1330
Unstable	1	≤ -0.17	0	8	0	2
Neutral	2	- 0.17 to 0.16	4	44	6	48
Moderately Stable	3	0.16 to 0.70	31	2	22	3
Very Stable	4	0.70 to 1.87	21	1	28	0
Extremely Stable	5	> 1.87	3	0	3	0
Total			59	55	59	53
Median			3	2	3	2
Mode			3	2	4	2

Note: Classified from surface to 327 meters above ground

(Data from Spangler, et al., 1974)

FIGURE II-15

AEC Pasquill Stability Class[a] Distributions from Temperature Soundings made During the Period February to June 1974

Stability Classification	Pasquill Categories	Temperature Change With Height ($^{o}C/100m$)	Fourmile Bench		Nipple Bench	
			0730 MST	1330 MST	0730 MST	1330 MST
Extremely Unstable	A	< - 1.9	0	0	0	0
Moderately Unstable	B	- 1.9 to - 1.7	0	0	0	0
Slightly Unstable	C	- 1.7 to - 1.5	0	2	0	0
Neutral	D	- 1.5 to - 0.5	27	50	28	52
Slightly Stable	E	- 0.5 to 1.5	32	3	31	1
Moderately Stable	F	1.5 to 4.0	0	0	0	0
Extremely Stable	G	> 4.0	0	0	0	0
Total			59	55	59	53
Median			E	D	E	D
Mode			E	D	E	D

[a]Classified from a layer between the proposed stack top and a point 200 meters above the stack.

(Data from Spangler, 1974)

FIGURE II-16

Stability Class Distribution of the Air Mass Above Nipple Bench
(January and February, 1971)

	Stability Class Distribution (Percent Frequency)		
	"D" (Neutral)	"E" (Slightly Stable)	"F" (Stable)
		Lowest 800 Feet	
0700 MST	22	75	3
1000 MST	38	58	4
1400 MST	70	30	0
		800 - 1600 Feet Above Sites	
0700 MST	26	71	3
1000 MST	26	71	3
1400 MST	67	30	3
		1600 - 3000 Feet Above Sites	
0700 MST	38	62	0
1000 MST	44	56	0
1400 MST	67	33	0

Note: Data determined from 114 observations. No Class A, B, or C were measured.

Data from Dames and Moore, 1973.

FIGURE 18

Frequency of Occurrence, Height of the Base, and
Depth of Measured Inversions above Fourmile Bench
From February 4, 1974 to July 5, 1974

Height of Inversion Base	Fourmile Bench 0730 MST	Fourmile Bench 1330 MST
No Inversion	24	42
Surface-100 m	29	2
101-200	1	0
201-300	1	1
301-400	0	0
401-600	1	3
601-800	1	2
801-1000	0	3
> 1000	2	2
Median	SFC-100	No Inv
Mode	SFC-100	No Inv
Number of Soundings	59	55

Inversion Thickness	Fourmile Bench 0730 MST	Fourmile Bench 1330 MST
No Inversion	24	42
0-100 m	18	7
101-200	10	5
201-300	4	0
301-400	2	0
401-500	1	0
501-1000	0	1
> -1000	0	0
Median	0-100 m	No Inv
Mode	No Inv	No Inv
Number of Soundings	59	55

Spangler et al. 1974

conducive to trapping of surface-released pollutants. However, it would also tend to inhibit an elevated release of pollutants from reaching the ground. These data also indicate that during the winter months, subsidence inversions are common, starting at about 6,500 feet MSL (Dames and Moore, 1973). Above this altitude the air warms with height. Below 6,500 feet, a generally isothermal region exists with surface inversions evident at the lowest levels.

Elevated stable layers may result in the trapping of stack emissions within a limited air volume. The vertical range of vigorous, turbulent mixing and pollutant dispersion is termed "mixing height." Mixing heights were tabulated from routine sounding data (Resource Data, 1974) (Figure II-18). Low mixing heights (to 300 meters) appear to dominate during morning hours, coincident with low-level or surface-based inversion layers. Mixing heights become greater toward afternoon, exceeding 1,000 meters in 36 of 55 observations.

The measurements were continued into the fall and more stable December and January periods and summarized by Golden and Spangler (1975). Spring, summer and fall periods are characterized by early shallow radiation inversions and occassional subsidence inversions. By afternoon both types of inversion have usually dissipated. Stabilities above stack top usually ranged from neutral to slightly stable in the early morning to neutral in the afternoon, suggesting good dispersions conditions. While average early morning mixing depths were somewhat limited due to the weak nocturnal inversion, afternoon mixing depths were generally more than 1,000 meters. During the winter period more inversions were apparent with resulting lower average mixing depths and greater stability.

Golden and Spangler summarized the vertical temperature data obtained from February 1974 through February 1975 as follows:

FIGURE II-18

Frequency of Occurrence of Various Mixing Heights at Fourmile Bench
(February 4, 1974, to July 5, 1974)

Mixing Height (m)	Frequency of Occurrence 0730 MST	1330 MST
0-100	35	1
101-200	11	3
201-300	6	0
301-400	3	2
401-600	0	4
601-800	1	5
801-1000	1	4
> 1000	2	36
Number of Soundings	59	55

Southern California Resource Data

a. The proposed stack heights were above more than two-thirds of all observed early morning surface inversions, suggesting a high incidence of plume lofting.

b. The spring, summer, and fall seasons all had generally neutral stability conditions during the afternoon indicating excellent plume dispersions conditions at that time.

c. More trapping inversions were evident during the winter with resulting lower mixing depths and increased stabilities. The high frequency of inversions observed indicate a strong probability of a trapping inversion continuing throughout the day.

d. Although there were minor seasonal variations, the differences between Fourmile Bench and Nipple Bench sites were minimal.

e. There were no observed cases when an unstable layer (A-C stability) was present below a trapping inversion. Several neutral stability conditions (Pasquill D) were observed below trapping inversions; however, rapid plume mixing to the surface during fumigation would not be as rapid as under A-C stability conditions.

Transmission system impact area

Summary

The area considered in this summary, noted for its expansive vistas, covers the proposed generating plant in southern Utah and the four segments of the proposed transmission system in Arizona, Nevada and southern California. This summary is intended to be broad enough to cover general air quality conditions of all alternate proposals for the transmission system. Since air quality is related to climate, general conditions noted here may be modified by local climatic conditions. Strong prevailing westerly winds over much of this region tend to keep air quality good to excellent most of the year.

Throughout the year, wind conditions are beneficial in that air pollutants are quickly dispersed and do not concentrate. Air quality monitoring stations are located at Page, Flagstaff, Prescott, Sun City, and Phoenix.

Occasionally, large forest and brush fires create excessive concentrations of gaseous pollutants and ashes. Also, localized winds cause severe degradation of the ambient air by stirring up large amounts of sand and dust. These influences are relatively short-lived and do not have a permanent effect. In analyzing segments of the proposed transmission system, there are several areas where existing ambient air quality is below the general high level previously depicted. The western half of Riverside County records levels of air pollution (oxidants) above state standards for about one-third of the year (Figure II-19). The Serrano area in Orange County probably has a similar record. federal and California air quality standards are shown in Figure II-20.

Although there are only a few air quality monitoring stations from the proposed generating plant to the southern terminus (Phoenix, Arizona) and western terminus (Orange County, California), those in Utah, Nevada and Arizona indicate ambient air quality is good to excellent except for some specific pollutant sources. These sources will be identified as specific segments are discussed. In southern California several areas are monitored because of the high general level of pollution, especially in the Los Angeles air basin (see Figure II-21).

Kaiparowits to Eldorado

This proposed route would traverse sparsely-populated areas of Utah, Arizona and Nevada but would pass close to several areas of man-caused pollutions:

Place and Source	Emissions
Fredonia, Arizona (oil refinery)	hydrocarbons
Moapa, Nevada (coal-fired electric generator)	several combustion products
Johns Manville Plant, Nevada (gypsum board)	dust
Apex, Nevada (limestone operation)	dust
Henderson, Nevada (industry)	organic oil chemical products
Las Vegas, Nevada (urbanization)	hydrocarbons and nitrogen oxides
Eldorado Valley, Nevada (mining)	dust

FIGURE II-19

Oxidant Trends in the South Coast Air Basin, 1963-1972
Three-Month Averages of Daily Maximum One-Hour Oxidant Concentrations
For July, August & September

Station	Concentration (ppm x 100)									
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Anaheim	11.4	9.6	15.9	14.1	12.5	11.9	13.7	10.7	8.9	8.7
Azusa	19.8	24.2	24.4	25.8	26.8	21.9	28.0	28.8	22.9	18.1
Burbank	15.1	15.6	20.9	17.0	22.5	19.0	19.4	18.5	16.1	13.2
Corona	16.4	25.6	16.7	13.8	22.1	16.2	22.0	20.8	13.4	--
Lennox	--	--	7.0	7.0	6.7	6.9	6.8	6.2	5.7	3.4
Long Beach	4.2	7.3	6.8	7.8	5.9	4.6	6.3	6.0	6.2	4.0
Los Angeles, Downtown	16.2	15.7	16.2	17.3	13.9	14.3	13.0	13.2	10.0	11.4
Pasadena	20.0	21.9	21.6	22.2	22.6	22.3	27.4	25.7	20.6	17.1
Pomona	--	--	20.8	21.4	23.9	20.8	24.5	23.5	16.6	14.6
Redlands	--	--	--	--	--	17.2	20.4	20.1	17.1	13.8
Reseda	--	--	18.6	19.6	20.9	18.0	20.1	17.4	14.2	12.1
Riverside	17.4	21.4	16.6	18.6	25.2	19.5	25.6	25.6	22.9	22.2
San Bernardino	15.5	12.2	17.0	17.0	18.2	15.2	18.9	23.1	18.7	14.8
West Los Angeles	11.9	10.3	11.3	11.6	11.1	11.2	11.0	10.1	8.4	7.1

Note: Blank spaces indicate stations were not operating.

Source: "Oxidant Trends in the South Coast Air Basin, 1963-1972," California Air Resources Board.

FIGURE II-20

Ambient Air Quality Standards Applicable in California

Pollutant	Averaging Time	California Standards: Concentration [g]	California Standards: Method [g]	Federal Standards [d]: Primary [b g]	Federal Standards [d]: Secondary [c a]	Federal Standards [d]: Method [e]
Photochemical Oxidants (Corrected for NO_2)	1 hour	0.10 ppm (200 $\mu g/m^3$)	Neutral Buffered KI	160 $\mu g/m^3$ [h]	Same as Primary	Chemiluminescent
Carbon Monoxide	12 hours	10 ppm (11 mg/m^3)	Non-dispersive Infrared Spectroscopy	- - -	Same as Primary Standards	Non-dispersive Infrared Spectroscopy
	8 hours	- - -		10 mg/m^3 (9 ppm)		
	1 hour	40 ppm (46 mg/m^3)		40 mg/m^3 (35 ppm)		
Nitrogen Dioxide	Annual Average	- - -	Saltzman Method	100 $\mu g/m^3$ (0.05 ppm)	Same as Primary Standard	Colorimetric Method Using NaOH
	1 hour	0.25 ppm (470 $\mu g/m^3$)		- - -		
Sulphur Dioxide	Annual Average	- - -	Conductimetric Method	80 $\mu g/m^3$ (.03 ppm)	60 $\mu g/m^3$ (0.02 ppm)	Pararosaniline Method
	24 hours	0.04 ppm (1.05 $\mu g/m^3$)		365 $\mu g/m^3$ (0.14 ppm)	260 $\mu g/m^3$ (0.10 ppm)	
	3 hours	- - -		- - -	1300 $\mu g/m^3$ (0.5 ppm)	
	1 hour	0.5 ppm (1310 $\mu g/m^3$)		- - -	- - -	
Suspended Particulate Matter	Annual Geometric Mean	60 $\mu g/m^3$	High Volume Sampling	75 $\mu g/m^3$	60 $\mu g/m^3$	High Volume Sampling
	24 hours	100 $\mu g/m^3$		260 $\mu g/m^3$	150 $\mu g/m^3$	
Lead (Particulate)	30-day Average	1.5 $\mu g/m^3$	High Volume Sampling, Dithizone Method	- - -	- - -	- - -
Hydrogen Sulfide	1 hour	0.03 ppm (42 $\mu g/m^3$)	Cadmium Hydroxide STRactan Method	- - -	- - -	- - -
Hydrocarbons (Corrected for Methane)	3 hours (6-9 a.m.)	- - -	- - -	160 $\mu g/m^3$ (0.24 ppm)	Same as Primary Standard	Flame Ionization Detection Using Gas Chromatography
Visibility Reducing Particles	1 observation	In sufficient amount to reduce the prevailing visibility [f] to 10 miles when the relative humidity is less than 70%		- - -	- - -	- - -

NOTES:

a Any equivalent procedure which can be shown to the satisfaction of the Air Resources Board to give equivalent results at or near the level of the air quality standard may be used.

b National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than three years after that state's implementation plan is approved by the Environmental Protection Agency (EPA).

c National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after implementation plan is approved by the EPA.

d Federal Standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year.

e Reference method as described by the EPA. An "equivalent method" of measurement may be used, but must have a "consistent relationship to the reference method" approved by the EPA.

f Prevailing visibility is defined as the greatest visibility which is attained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

g Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 mm of mercury.

h Corrected for SO_2 in addition to NO_2.

FIGURE II-21

Days on Which Oxidant Level Exceeded State Standards (1971)*

Month	Riverside	Banning	Palm Springs	Indio
Jan	8	1	3	0
Feb	11	0	7	1
Mar	16	10	16	10
Apr	14	2	15	12
May	17	6	13	16
Jun	25	15	23	27
Jul	31	19	17	27
Aug	31	12	10	20
Sep	28	5	15	19
Oct	15	1	3	8
Nov	11	0	4	2
Dec	0	0	0	0
	207	71	126	142

*California State Standards for Oxidant Level = 0.1 ppm/1 hour.

Information in the above table was originally published in the Annual Report of the Riverside County Air Pollution Control District (1971).

Dust pollution is seasonally commonplace throughout this area and major brush fires occasionally occur in the vicinity of the Arizona-Nevada border, causing heavy but temporary pollution.

Moenkopi to Mohave

This proposed route also would cross an area of sparse population and few towns. Starting near Cameron it would go west to the Mohave Power Plant at Lauflin, Nevada (across the Colorado River from Bullhead City, Arizona). This coal-fired electric generating plant creates the heaviest concentration of pollution along this proposed route.

This route would cross U.S. 66, I-40 and the Atchinson, Topeka and Santa Fe Railroad near Kingman, Arizona and Nelson, Arizona, but pollution is minimal at these points.

Kaiparowits to Phoenix

This proposed route would pass through an area of low population with few sources of man-made pollution until it reaches the outskirts of Phoenix. However, it would pass a few miles southwest of Page, Arizona and the coal-fired generating plant there. In the Phoenix area, periods of inversions occasionally concentrate pollutants but neither federal nor state air standards have been exceeded since 1969. Along U.S. 89 on the Navajo Reservation dust storms have been severe enough to delay or stop traffic.

Mohave to Serrano

This route can best be described in three subsegments:

(1) Mohave Desert subsegment would run from the Mohave generating plant southwest to Coachella Valley (Palm Springs area). This desert has excellent quality air, even though occasionally degraded by dust storms.

(2) Coachella Valley subsegment has two serious air quality problems. There is a strong influx of automotive and other pollutants from the Los Angeles

basin through the Banning Pass area added to local pollution from a major freeway (I-10) and from several cities in this valley. The second air quality problem is a natural phenomenon of winds that flow through the Banning Pass area causing violent sand and dust storms. Winds up to 100 miles per hour have been noted in this area. The proposed route would parallel the freeway and proceed west through Banning Pass.

(3) The Valley subsegment would continue west to Serrano substation. Although this segment is not subject to the heavy wind and dust conditions of the previous subsegment, the proposed route would run through an area in which federal air standards are exceeded on some days nearly every month of the year and nearly every day of the month during June through September (see Figure II-21). Serious oxidant pollution occurs in Riverside, and the city of Orange. Significant levels of oxidants also have been recorded in Banning and Corona. All of these cities, except Riverside, are relatively near the proposed route.

Northern Kaiparowits to Mohave preferred alternate

This proposed route would begin in an area of southern Utah desert which has excellent air quality. This route would be immediately adjacent to the existing Eldorado-Kaiparowits 500 kilovolt (kV) transmission line (recently constructed by Los Angeles Power and Water).

The route would go south and west from Kaiparowits past the Buckskin Mountains into Arizona and pass about 10 miles southeast of Fredonia, Arizona. Continuing west the line would go through relatively primitive country with excellent air quality. The route would cross Interstate 15 and old U.S. 91 in the Virgin River Canyon and Beaver Dam Mountains, where air quality is good. Every few years, major brush fires cause temporary degradation of air quality in this area.

Further west the line would enter Nevada and cross the south end of Mormon Mountains and then pass within 1 mile of the coal-fired plant at Glendale. This plant is now in compliance with Clark County, Nevada air quality standards. From this point on, the air quality is somewhat degraded by automotive pollution, highways, railroads, Las Vegas, Boulder City, and Henderson, but is considered good by Clark County Health Department Air Quality Control. South of Eldorado substation (about 30 miles south of Henderson, Nevada) the area of the route has good quality air until it reaches the Mohave generating station at Bullhead City, Nevada. According to Clark County officials, the Southern California Edison plant is not presently complying with county air pollution standards.

Arizona Strip preferred alternate

This proposed route would follow the same alignment at the beginning as the Northern Kaiparowits to Mohave preferred alternate. South of Pipe Springs National Monument in Arizona this alternate would bear off to the southwest, crossing the Hurricane Fault and continuing west just south of Seegmuller Mountain (a prominent landmark visible from St. George, Utah). Throughout this proposed route the air quality is excellent with no man-caused intrusions.

The route would continue west to the south of Black Rock Mountain and through the Virgin Mountains into Nevada about 8 miles south of Mesquite, Nevada. The line would continue some 20 miles west-southwest across Mormon Mesa and tie into the previously described route of the Northern Kaiparowits to Mohave 500 kV transmission line preferred alternate. Throughout the proposed route, existing air quality is excellent.

This area, like others in the southern Utah-northern Arizona-Nevada area, is subjected to periodic severe air degradation because of brush fires. This condition is especially prevalent in the western Virgin Mountains and Mormon Mesa area.

Noise and electrical interference summary

The area covered in this discussion is the same as that covered by the air quality discussion.

Many of the same factors responsible for the absence of air pollution would also be applicable for the absence of noise pollution. Thus, most of the proposed routes - away from cities, most major highways and rail lines, and, in the Main, away from factories and plants - have very low ambient noise levels. This noise is very near the ambient level in nature without man or machines.

The only areas along the proposed routes where the ambient noise level could rise above this low level would be where the routes cross a major highway, railway or near a factory, power plant or city.

In southern California a different type of noise pollution would be found in the vicinity of the proposed route from Coachella Valley to the western terminus. This would be caused by off road vehicles (i.e., motorcycles and dune buggies).

Over most of the proposed routes there are existing audible noise effects, electrical interference and ozone production from existing power lines.

Ozone production

Ozone (O_3) is the triatomic molecule of oxygen characterized as a faint bluish gas with a pungent odor. It is produced by decomposition of oxygen or nitrogen oxide molecules. It is a toxic gas which can produce adverse effects on plant and animal life if concentrations are high enough. It has a half-life (the time required for the concentration to be reduced by one-half) of about 1 hour.

Ozone can be produced in the vicinity of extra high-voltage transmission lines by corona discharges. Ozone is also produced by many other processes, including natural processes, and is one of the natural pollutants of air. The existing background atmospheric concentration of ozone at sea level is between 0.01 and 0.03 ppm with the highest levels reached during inclement weather.

Acceptable continuous exposure to ozone concentrations as specified by the Occupational Safety and Health Act (OSHA) of 1972 is 0.1 ppm for any 8-hour period.

Even though ozone has a pungent odor, concentrations at background levels are so low that it is generally not detected by human senses. However, additions of small quantities to the background values - reaching approximately 0.05 ppm, - can be detected by the human nose. The two most common ozone-producing phenomena of concentrations detectable by humans are lightning and electrical sparks.

Recent studies conducted by Commonwealth Edison and American Electric power companies have demonstrated that ozone concentrations generated by conductor corona on existing 765 kV transmission lines are not measureable above the ambient values at ground level under any weather conditions.

Electrostatic effects

Electrostatic effects of a high-voltage transmission line are due to the voltage gradient which induces a voltage onto ungrounded objects near the line. This induced voltage is a function of line voltage, insulation, object dimensions, line height, and position of the object. The threshhold of voltage sensation is about 10 to 15 kV/m which decreases rapidly as the distance from the line increases.

The most common concern for people near transmission lines or substations is "capacitive discharges." Capacitive discharges occur when two bodies of a different potential come in contact. Current flowing into a human body depends on body resistance. Human response to a capacitive discharge depends on both the open-circuit voltage and the capacitance which is discharged. The discharge creates an arc similar to that generated by static electricity when a person walks across nylon carpeting.

Ungrounded metal objects near a transmission line will become charged and acquire an electrical potential due to the line. In some instances, a person may experience a slight stinging sensation when touching these objects. Discomfort caused by voltage induced on an ungrounded metal object depends on the area of the surface lateral distance from the conductor, and height of the surface above ground. Surfaces of less area, closer to the ground and further from the conductor will produce lower values of current.

Another consequence of induced voltage is the possibility of gasoline vapor ignition. Voltage induced by 500 kV lines is not sufficient to cause fuel ignition. Clearances on 500 kV lines and fuel-to-air mixture concentrations are such that ignition would not occur, even during the refueling of large trucks near the line.

Limestone quarry impact area

No air quality data have been collected in the general area of the proposed quarry site. The proposed site area is on a high plateau with unrestricted air circulation and is remote to air pollution from industries and population centers. The air quality of the area can be expected to be excellent.

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Geology and topography

Kaiparowits Plateau impact area

General

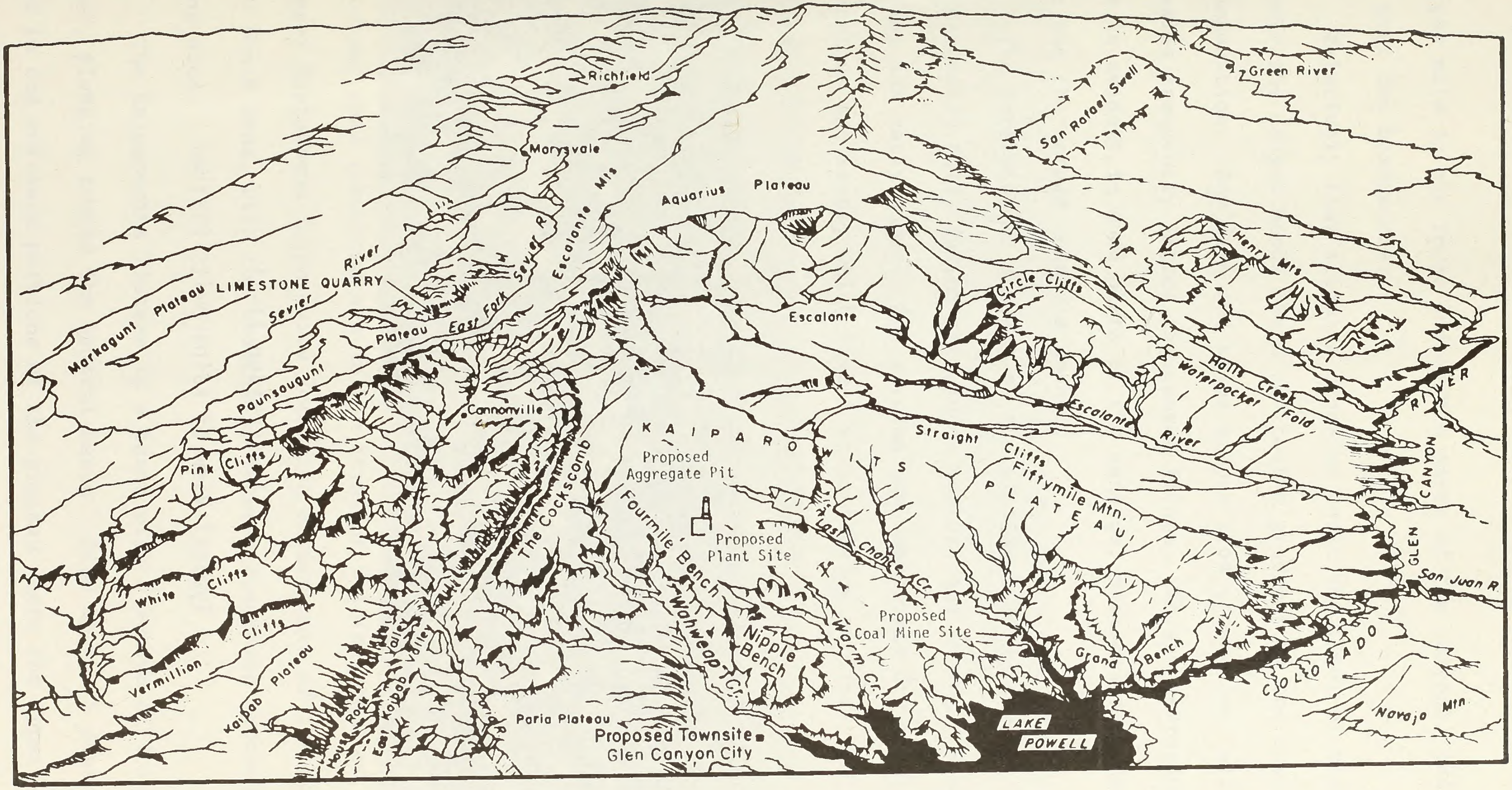
The Kaiparowits Plateau embraces an area of approximately 1,600 square miles of sedimentary rock (Doelling and Graham, 1972). The plateau is bounded on the north by the Aquarius Plateau, on the east by the Straight Cliffs (Fiftymile Mountain), on the south by a high erosional escarpment cut by several tributary canyons to Lake Powell, and on the west by the East Kaibab Monocline (the Cockscomb) (Illustration II-10).

The plateau lies wholly within the Canyonlands section of the Colorado Plateau physiographic province. Topographically, the plateau is an undulating surface, deeply cut by steep-walled canyons. The region is characterized by terraced plateaus, vertical cliffs, cliff-bound benches, and deep canyons (Gregory and Moore, 1931). A typical view of the terrain is shown in Illustration II-11.

Elevations range between 3,000 and 8,600 feet, mean sea level, the northern part of the plateau being higher than the southern. Average elevation is about 6,100 feet.

Drainage in the northern part is into the Escalante and Paria Rivers, and in the southern part directly into Lake Powell. Along the northern shore of Lake Powell, the main drainages are Rock Creek, Little Valley, Croton Canyon, Last Chance Creek, Warm Creek and Wahweap Creek. All of these drainages are intermittent. Only the Colorado River (Lake Powell) and the nearby Paria and Escalante rivers are perennial.

Drainages have cut into the plateau, forming deep, winding canyons that separate the individual benches. The canyons are deepest near the cliffs which bound the plateau and decrease in depth upstream. The canyons are from 3 to 10 miles in length and range in width from about 1/2 mile near the mouths to several hundred feet near the heads. Gradients of the canyon bottoms are between 60 to



(Modified from Gregory and Moore, 1931)

ILLUSTRATION II-10

Kaiparowits Plateau Region

Looking North From Utah-Arizona State Line

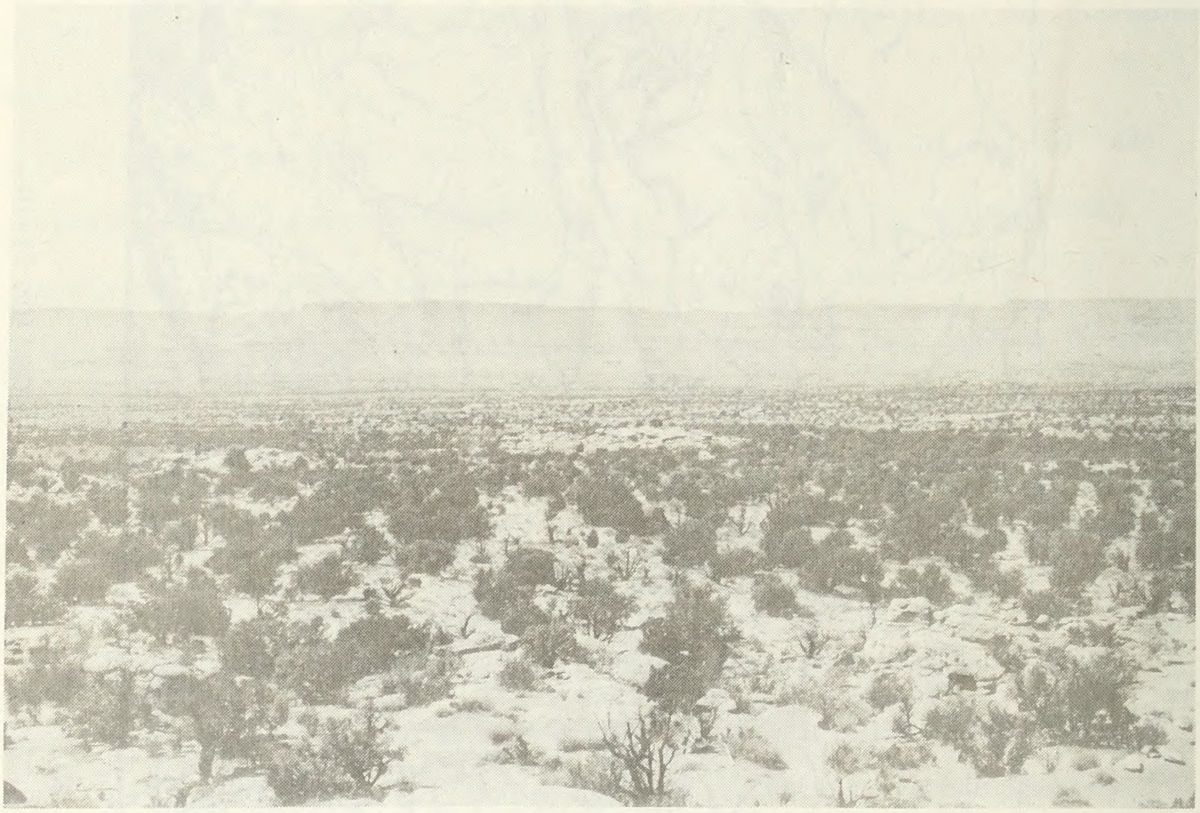


Illustration II-11

Typical View of Kaiparowits Plateau

90 feet per mile in the lower and middle parts of the canyons, and somewhat steeper near the headwaters.

Relatively flat alluvial deposits cover the floor of most canyons, except near the canyon heads where the bottom gradient is too steep to permit stream deposition. Boulders and talus slopes from erosion or collapse of the canyon walls frequently litter the canyon floors. Stream terracing of the alluvium is evident in some parts of the canyons, particularly where the canyons are wide and the stream channels meander.

The intermittent streams of the plateau flow during the rainy season of late summer-early fall, during the winter months, and during the spring thaw. In late spring and early summer, the streams are completely dry except for occasional springs and seeps, which reveal water-bearing aquifers and subterranean stream flows.

The rainy season, usually accompanied by violent thunderstorms, brings substantial surface-stream swelling. Watermarks on the canyon sides indicate that, at times, entire canyon bottoms have been flooded by swiftly-flowing, violent flash floods. More erosion occurs during the rainy season than during the rest of the year.

Excluding recent Tertiary and Quaternary surface cover, the entire plateau is of Cretaceous sedimentary rocks (Illustration II-12 and Figure II-22). The important coal resources are in the Straight Cliffs formation (Figure II-23). The Upper Cretaceous Kaiparowits formation covers much of the surface of the Fourmile Bench area, with the underlying Wahweap formation exposed over the remaining area.

The Kaiparowits Plateau is a basin with a system of folds trending northwest, plunging toward the Central basin. Dips up to 45 degrees have been measured in the northern portions of the plateau where the Upper Valley anticline dips west into the Table Cliff syncline. In the south-central portion, three

FIGURE II-22

Generalized Section of Cretaceous Sediments in Kaiparowits Plateau

POST-CRETACEOUS TERTIARY AND QUATERNARY

System	*Series*	*Stratagraphic Unit*	*Thickness (ft)*	*Description*
CRETACEOUS	Campanian	Conglomeratic member	0- 500	Red and gray mudstone and bentonitic claystone overlying interbedded light brown, gray, pink and red sandstone, conglomeratic sandstone and conglomerate.
		— Unconformity —		
CRETACEOUS	Campanian	Kaiparowits Formation	2,000-2,500	Gray to dark gray, fine- to moderately coarse-grained, friable 'salt and pepper' arkosic sandstone with subordinate light gray mudstone; weak calcareous cement, forms badlands and slopes.
CRETACEOUS	Campanian	Wahweap Formation	760-1,350	Yellow-gray resistant sandstone, gritstone and conglomerate alternating with yellow-orange nonresistant sandstone and gray mudstone; lower half dominantly nonresistant, upper half massive and hard.
CRETACEOUS	Campanian	Straight Cliffs Formation, Upper: Drip Tank Member	100- 350	Yellow-brown to gray-orange, fine- to medium-grained sandstone with some gritstone and conglomerate interbedded with subordinate gray shale; resistant cliff former.
CRETACEOUS	Campanian; Santonian; Coniacian	Straight Cliffs Formation, Upper: John Henry Member *MAJOR COAL SEAMS*	500- 900	Interbedded yellow-gray, white and orange medium-grained sandstone, gray shale, carbonaceous mudstone and *coal*; forms ledgy outcrops; often exhibits reddish to black outcrops from clinker and burned sandstone due to natural burning of coal.
		— Unconformity —		
CRETACEOUS	Turonian	Straight Cliffs Formation, Lower: Smoky Hollow Member *MINOR COAL*	24- 500?	Interbedded white or yellow-gray sandstone, light gray to dark gray mudstone and sometimes thin *coal* seams; lower part ledge to slope forming, upper part cliff forming.
CRETACEOUS	Turonian	Straight Cliffs Formation, Lower: Tibbet Canyon Member	70- 185	Yellow-gray and gray-orange, medium-grained sandstone interbedded with subordinate gray mudstone; cliff former.
CRETACEOUS	Turonian	Tropic Shale *MINOR COAL*	550-1,000	Medium- to dark-gray argillaceous to sandy shale, contains thin yellow-gray sandstone beds at top and base, otherwise uniform; forms badlands and slopes.
CRETACEOUS	Cenomanian	Dakota Formation *MINOR COAL*	0- 250	Yellow-gray sandstone alternating with gray shale, carbonaceous shale and *coal*; forms semiresistant ledge.

PRE-CRETACEOUS JURASSIC

(Modified from Doelling and Graham, 1972, p. 74)

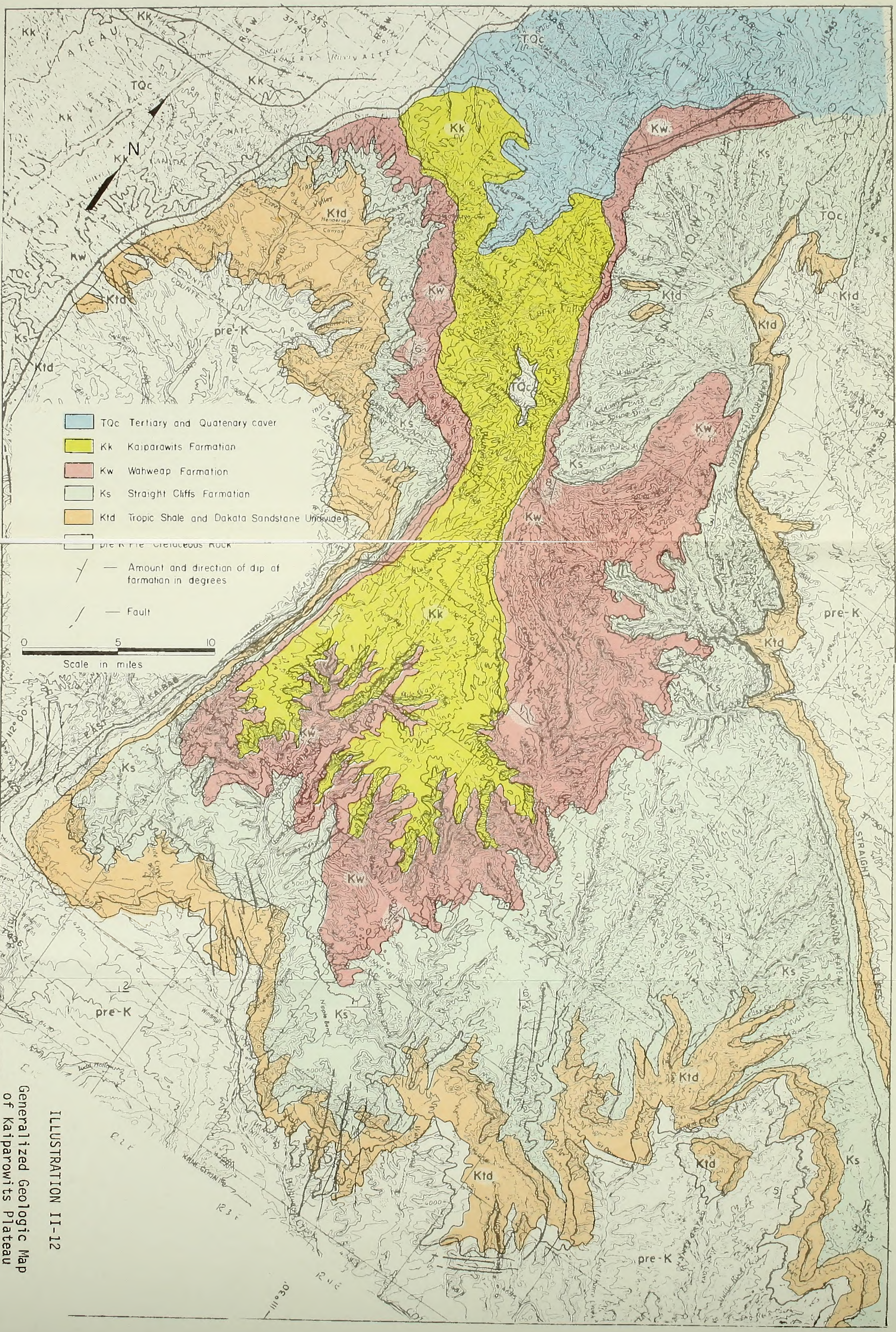
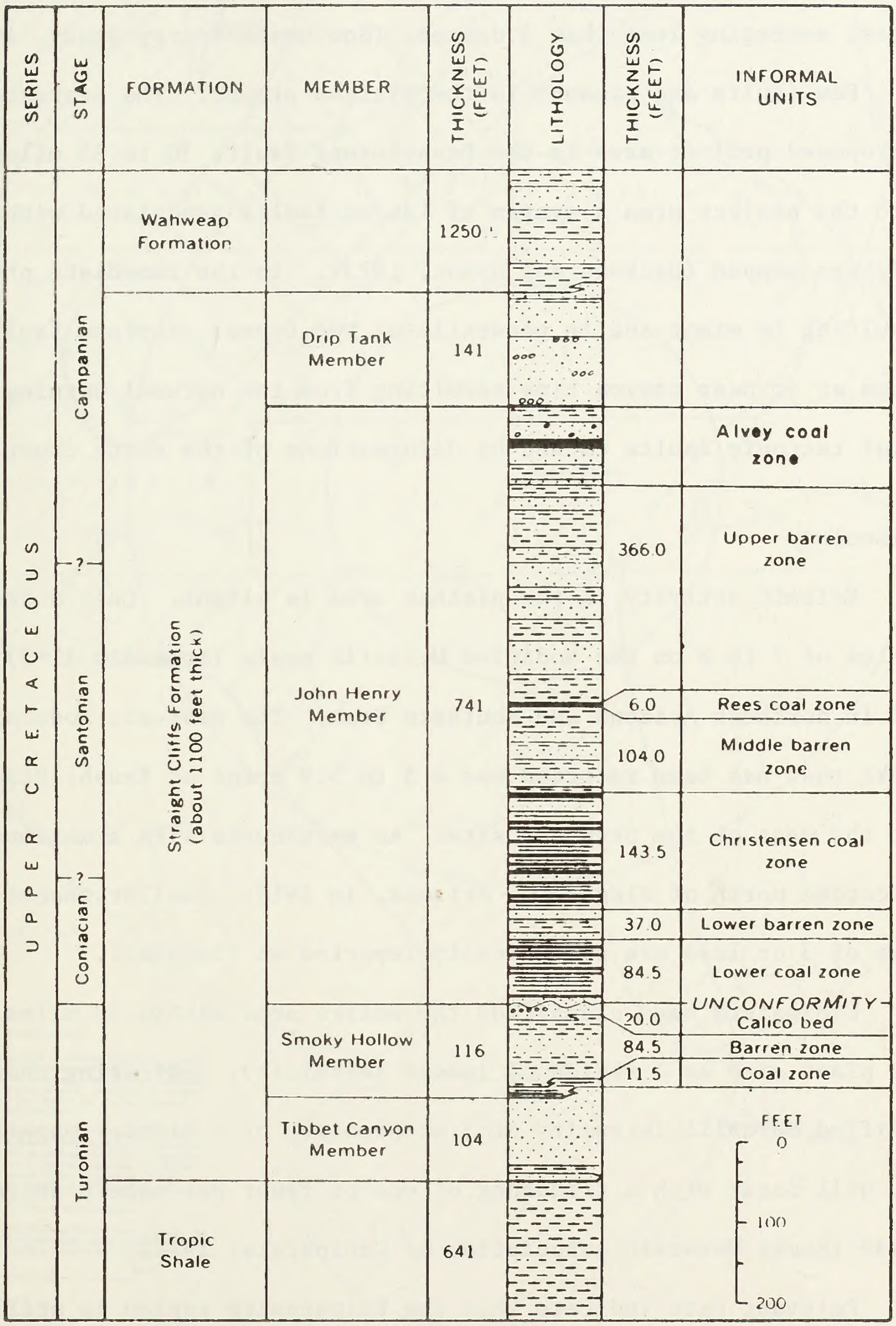


ILLUSTRATION II-12
Generalized Geologic Map
of Kaiparowits Plateau

FIGURE II-23

Composite Columnar Section - Straight Cliffs Formation



(Modified from Peterson, 1969)

northwesterly-trending folds - the Last Chance syncline, the Smoky Mountain anticline, and the Warm Creek syncline - constitute the principal structures in the proposed project area. Dips in the flanks of these structures seldom exceed 10 degrees, averaging less than 5 degrees (Southwest Energy Study, 1972).

Few faults are present in the plateau proper. The nearest major fault to the proposed project area is the Paunsaugunt Fault, 30 to 35 miles to the west. Closer to the project area a system of lesser faults associated with the Cockscomb area has been mapped (Hackman and Wyant, 1973). In the immediate proposed project area, faulting is minor and is generally of two types: surface faults or collapse structures at or near canyon rims resulting from the natural burning of coal beds, and normal tectonic faults caused by deformations of the earth crust.

Seismology

Seismic activity in the plateau area is slight. Only a few shocks of intensities of 7 to 8 on the Modified Mercalli scale (Appendix II-3) have been recorded in northern Arizona and southern Utah. The nearest, moderate-sized earthquake that has been recorded was a 5 to 5.9 event at Kanab, Utah, about 50 miles to the west of the proposed site. An earthquake with a maximum intensity of 7 was recorded north of Flagstaff, Arizona, in 1912. Smaller shocks with intensities of 3 or less are periodically reported at Flagstaff.

Geologists have classified the entire area within 50 miles of the proposed plant site as a region of lesser seismicity, indicating that earthquakes of a Modified Mercalli intensity of 7 or greater, or a Richter magnitude of 5 or greater, will occur with a frequency of one or fewer per square degree of surface per decade (Rocky Mountain Association of Geologists, 1972).

Relevant data indicate that the Kaiparowits region is still active and that earthquakes of low intensity will occur (Illustration II-13). However, the

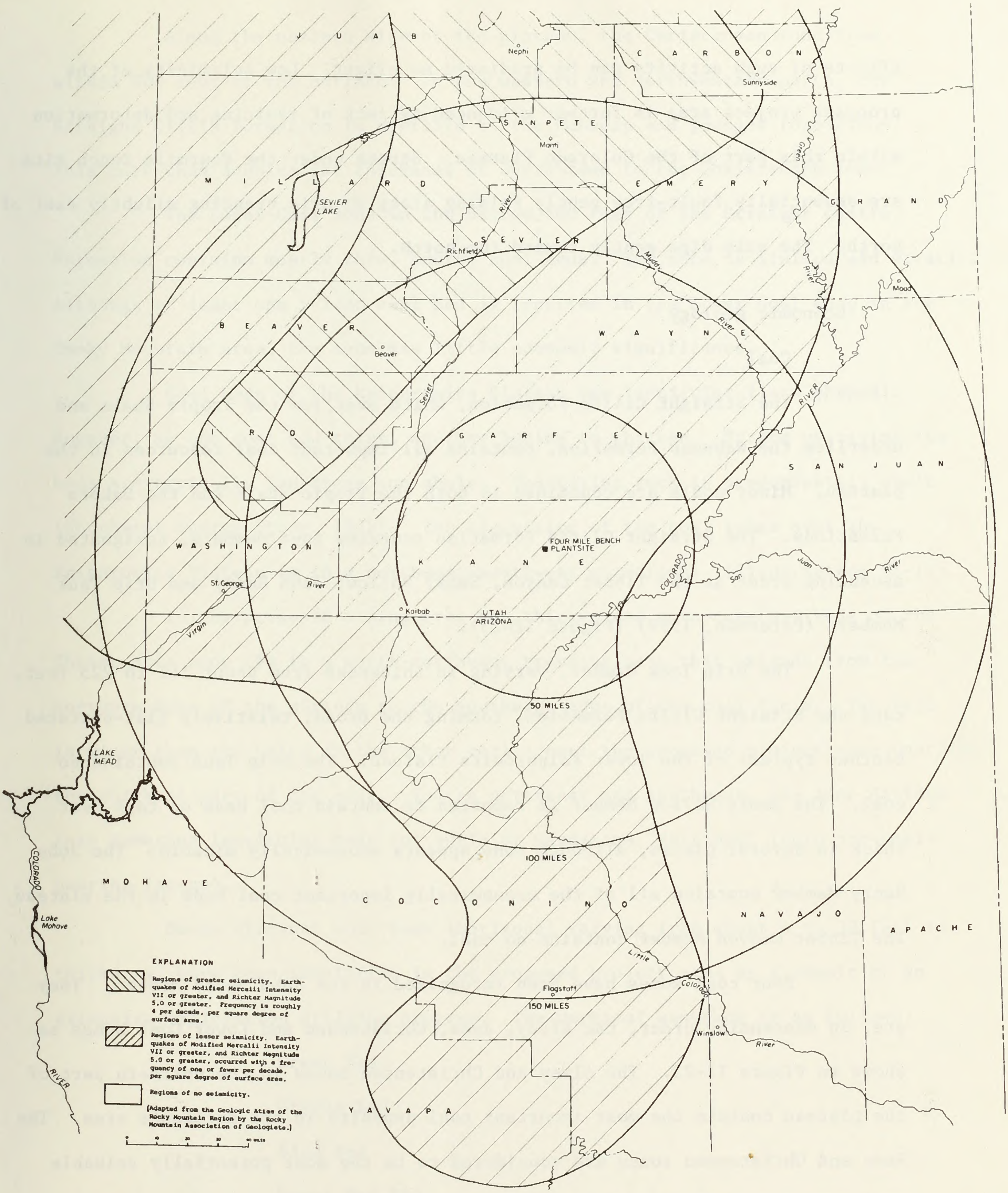


ILLUSTRATION II-13

Seismicity of Project Area

effects of such activity can be predicted as slight. Low seismicity of the proposed project area is further evidenced by lack of faulting and deformation within this part of the Colorado Plateau. Strata under the Fourmile Bench site are essentially fault-free gently folding along an axis trending slightly east of north. The axis dips gently toward the north.

Economic geology

Coal

The Straight Cliffs Formation, which overlies the Tropic Shale and underlies the Wahweap Formation, contains all important coal resources in the plateau. Minor coals are contained in both the Tropic Shale and the Dakota Formations. The Straight Cliffs Formation contains four members, designated in ascending order as the Tibbet Canyon, Smoky Hollow, John Henry and Drip Tank Members (Peterson, 1969) (Figure II-23).

The Drip Tank Member, varying in thickness from about 141 to 225 feet, caps the Straight Cliffs Formation, forming the broad, relatively flat-surfaced benches typical of the lower Kaiparowits Plateau. The Drip Tank contains no coal. The Smoky Hollow Member is reported to contain coal beds up to 4 feet thick in several places, although none appears economically minable. The John Henry Member contains all of the economically important coal beds in the plateau. The Tibbet Canyon Member contains no coal.

Four coal zones have been recognized in the John Henry Member. They are, in descending order, the Alvey, Rees, Christensen and Lower Coal zones as shown in Figure II-23. The Alvey and Christensen zones in the northern part of the plateau contain the most important coal deposits in the Escalante area. The Rees and Christensen zones are considered to be the most potentially valuable coal producing zones in the Smoky Mountain area.

Along the eastern side of the plateau, the Christensen zone lies within 800 feet of the surface. In the western and northwestern parts, the Straight Cliffs Formation is overlain by the Wahweap and younger formations. This more than doubles the thickness of overburden to the Christensen zone.

The Lower Coal zone in the bottom 500 feet of the Straight Cliffs Formation contains mostly thin, spotty coal beds. The zone is limited and erratic. Although at least one 5-foot coal bed is reported in the Lower Coal zone in the Smoky Mountain area, the zone has little economic significance.

Coal beds of the Kaiparowits Plateau are lenticular (lens shaped). However, as one coal bed thins, another begins to thicken. Strata overlying the beds are typically sandstone and shale. Underlying rock is predominately shale (Southwest Energy Study, 1972). The transition of the coal zones over the Kaiparowits Plateau is in a northeast-southwest direction. (Illustration II-14).

In the proposed mining area the thicker and more numerous beds of the Christensen zone lie in a north-northwest trending belt that extends from the northern edge of the plateau to the southeast edge of the coal field. The belt is wider than the belts in the other coal zones; the proposed project area overlies the thickest part of the zone. To the northeast and southeast, the zone divides into numerous lenticular beds and shale or sandstone "partings" (thin non-coal-bearing layers).

Seven distinct coal beds (horizons) varying from about 4 to 30 feet in thickness, have been identified in the proposed project area as a result of an extensive exploration drilling program. The vertical sequence is as follows:

Green Bed

Orange Bed

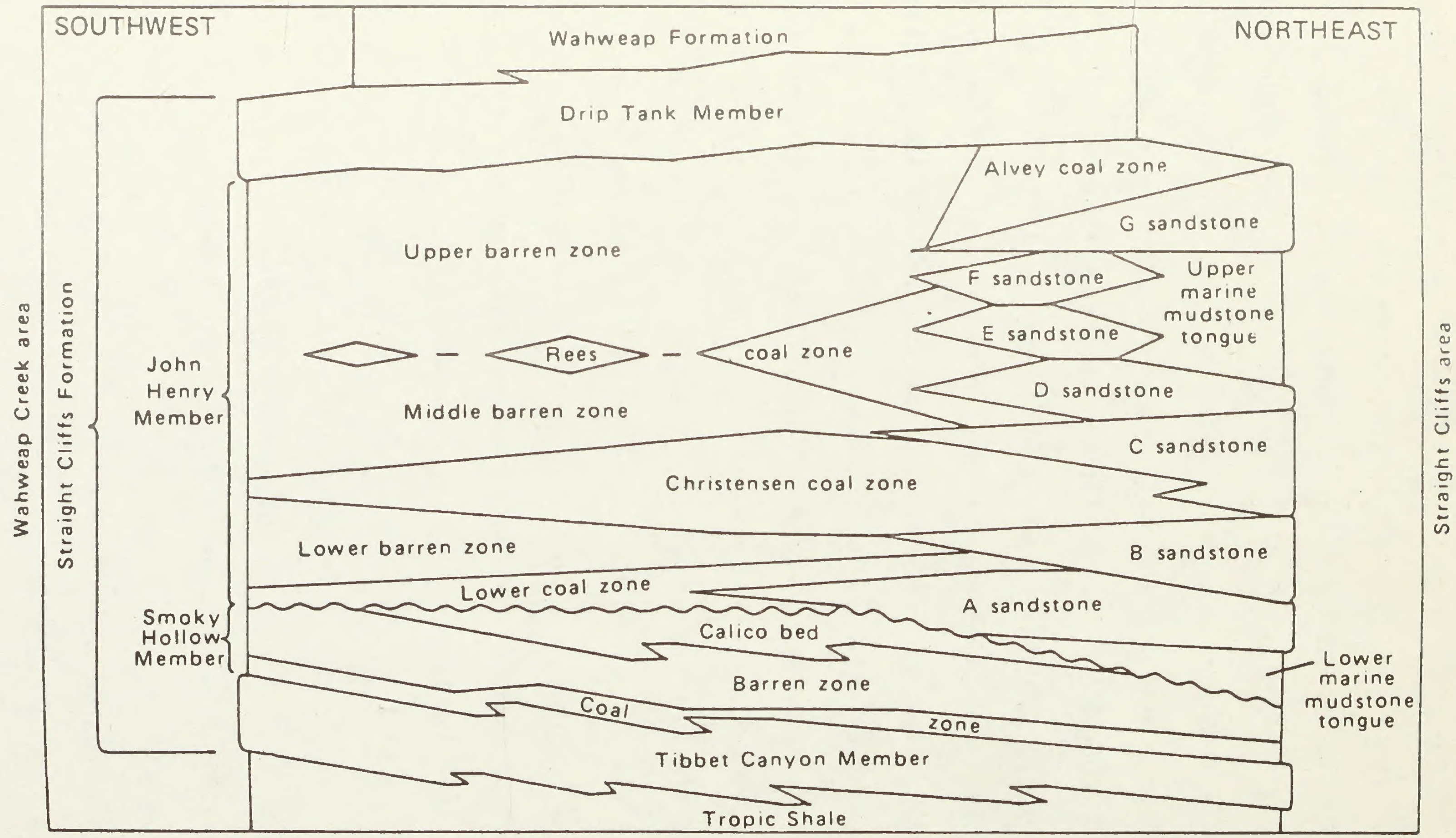
Blue Bed

Upper Red Bed

Lower Red Bed

Brown Bed

Lilac Bed



(from Peterson, 1969, p. J8)

ILLUSTRATION II-14

Relations of Members and Informal Units in the Straight Cliffs Formation - Southeast Kaiparowits Plateau Coal Field

A typical cross section through the heart of the area initially proposed for mining is shown in Chapter I.

The U.S. Geological Survey (USGS) has been conducting an intensified geologic mapping and coal resource evaluation program in the Kaiparowits Plateau since the early 1960's. As of January 1, 1967, the USGS estimated a total resource of 7.3 billion tons of coal under 3,000 feet, or less, of cover (Averitt, 1969).

As more information became available the Utah Geological and Mineralogical Survey calculated total reserves under the following classification (Doelling and Graham, 1972):

Class	Type of Reserve	Explanation
I	Measured reserves	Based on adequate exploration and development data, properly correlated.
II	Indicated reserves 3,984,800,000 tons (Includes a small amount of Class I reserve)	Based on geologic measurement supplemented by limited drill-hole information and limited to 1 1/2 miles from a control point.
III	Inferred reserves 3,893,200,000 tons	Based on geologic inference and projection of the habit of the coal beyond 1 1/2 miles from control points.
IV	Additional inferred 7,320,000,000 tons	Based on geographic and geologic position with little supporting data and includes coal up to 3,000 feet of cover.
Total	15,198,000,000 tons	

With continued field mapping and expanded exploratory drilling on the plateau it is expected that the reserve totals will be refined upwards appreciably.

Resources Company, a subsidiary affiliate of the participants, has estimated that their lease holding, constituting approximately 21 percent of all

leased Kaiparowits coal lands, contains about 1.5 billion tons, in beds 4 feet thick or greater, based on limited exploratory drilling of the Straight Cliffs Formation coals.

A recent USGS evaluation of coal reserves at the proposed Fourmile Bench plant site, based on nearby drill hole data, indicates that as much as 92 million tons of coal underlie the site, in beds 4 feet thick or greater (Peterson, 1974). The coal is 1,900 feet below the surface.

The quality of coal from the entire Kaiparowits Plateau is extremely variable. Quality ranges from subituminous C to high-volatile bituminous A. Sulfur content is low to high, ranging between 0.26 and 3.40 percent, with ash varying from 3.38 to 33.03 percent. Heating value is moderate to high, ranging from 8,499 to 14,236 British thermal units (Btu) per pound (Doelling and Graham, 1972).

The coal has no coking properties and in most cases would require mechanical cleaning to produce a satisfactory fuel for power production, gasification, or liquification. Alvey zone coal is generally of lower quality than coal of the Christensen zone.

A detailed analysis of coal sampled from exploration core drilling by the participants is shown in Figure II-24. Data concerning concentrations of trace elements are shown in Figures II-25 and II-26.

Coal has never been mined extensively in any part of the Kaiparowits Plateau. Numerous small mines have operated around the periphery of the plateau, mostly in the general areas of Escalante and Tropic. The Alvey mine near Escalante was the largest, with a production of about 1,250 tons per year between 1952 and 1961. All other mines produced 100 tons a year or less. At present, there are no producing mines in the area.

FIGURE II-24

Burned Coal Analysis by Resources Company

Proximate Analysis - %	Average*	Range
Moisture	12.55	11.60 - 13.25
Ash	9.25	8.75 - 10.00
Volatile Matter	36.60	33.00 - 39.30
Fixed Carbon	41.60	38.90 - 45.40
Total	100.00	
Sulfur	0.52	0.21 - 1.43
Heating Value, BTU/lb. (as received)	10,800	10,600 -11,000
<u>Ultimate Analysis - %</u>		
Moisture	12.55	11.60 - 13.25
Carbon	61.32	58.60 - 63.60
Hydrogen	4.33	3.90 - 4.75
Nitrogen	0.95	0.45 - 1.30
Chlorine	0.02	0.00 - 0.06
Sulfur	0.52	0.21 - 1.43
Ash	9.25	8.75 - 10.00
Oxygen (by differential)	11.06	9.72 - 12.55
<u>Ash Fusion Temperature - °F</u>		
Reducing - Initial def.	2235	2070 - 2700+
- Soft (H=W)	2300	2130 - 2700+
- Soft (H=½W)	2385	2145 - 2700+
- Fluid	2510	2155 - 2700+
Oxidizing - Initial def.	2265	2135 - 2700+
- Soft (H=W)	2360	2150 - 2700+
- Soft (H=½W)	2445	2210 - 2700+
- Fluid	2580	2220 - 2700+
<u>Ash Analysis</u>		
Silica, SiO_2	55.44	41.33 - 74.60
Ferric oxide, Fe_2O_3	4.97	2.20 - 9.50
Alumina, Al_2O_3	17.81	11.91 - 29.30
Titania, TiO_2	0.94	0.58 - 1.30
Lime, CaO	9.13	1.50 - 22.00
Magnesia, MgO	2.04	0.31 - 4.97
Sulfur trioxide, SO_3	6.86	0.34 - 14.90
Phosphate pentoxide, P_2O_5	0.27	0.04 - 1.94
Potassium oxide, K_2O	0.61	0.51 - 1.75

(Continued)

FIGURE II-24 (Continued)

Ash Analysis	Average	Range
Sodium oxide, Na_2O	1.50	0.68 - 3.30
Undetermined	0.43	0.01 - 1.06
Alkalies in dry coal as Na_2O	0.17	0.03 - 0.37
Water soluble alkalies Na_2O	0.058	0.038- 0.101
Water soluble alkalies K_2O	0.003	0.001- 0.013
Silica Value	77.31	50.24 - 94.09
Grindability index (Hardgrove)	46.5	38.9 - 52.6
Free Swelling index	1	0 - 2
Viscosity - Crit. temp.		
Poises	640	28 - 1140
°F	2580	2360 - 2645
T 250 °F	2655	2135 - 3000+
Disposal - in place density	60 lb/ft^3	

*The table is based upon analysis of 103 core samples taken from 50 bore holes durin the coal drilling exploration program through 1972. The analyses were performed by Commercial Testing and Engineering Company in Denver, Colorado and were checked by the Colorado School of Mines Research Institute in Golden, Colorado. The results ar based upon a washed coal product and are representative of the actual coal to be burned at the generating station.

FIGURE II-25

Trace Element Analysis of Coal from Four Mine Sites at Kaiparowits

Element	Environmental Research Group, Inc[a]			Truesdail Laboratories			Trapelo/West		Union Carbide[a]			US Bureau of Mines[b]	
	(ppm)											Coal	Ash
Mercury	0.16	0.15	NA&FAA[c]	0.005	0.005	FAA	--d		0.03	0.02	NA	0.04	--d
Beryllium	--d	0.75	FAA[e]	0.3	0.4	AA[f]	0.48	AA	--d	--d		--d	7.0
Nickel	3.9	3.9	NA&FAA	5.0	4.9	AA	5.4	AA	6.8	--d	NA	--d	70.0
Cadmium	--d	--d		0.7	1.9	AA	0.18	AA	0.7	--d	NA	--d	2.0
Chromium	3.21	2.9	NA&FAA	5.7	5.6	AA	--d		5.0	5.8	NA	--d	70.0
Manganese	4.2	4.7	NA&FAA	8.2	7.9	AA	5.7	AA	4.8	5.3	NA	--d	--d
Vanadium	9.4	10.0	NA&FAA	7.4	7.8	AA	8.8	AA	6.5	7.4	NA	--d	100.0
Arsenic	--d	--d		2.3	0.8	CC[g]	0.62	CC	0.11	0.13	NA	1.0	--d
Fluorine	69.0	78.0	NA&FAA	7.4	55.4	CC	2.25	CC	--d	--d		110.0	--d
Selenium	3.0	2.8	NA&FAA	12.5	4.6	CC	5.2	CC	0.6	0.5	NA	3.0	--d
Thorium[232]	--d	--d		--d	--d		$1.7x10^{-1}$pCi/g	Ct[h]	--d	--d		--d	--d
Thorium[228]	--d	--d		--d	--d		$1.8x10^{-1}$pCi/g	Ct	--d	--d		--d	--d
Thorium[230]	--d	--d		--d	--d		$2.9x10^{-1}$pCi/g	Ct	--d	--d		--d	--d
Radium[226]	--d	--d		--d	--d		$1.3x10^{-1}$pCi/g	Ct	--d	--d		--d	--d

Note: Samples are composites from all four mines

a Duplicate coal analysis
b One sample of coal and one sample of ash analyzed
c NA&FAA - Neutron Activation Flameless Atomic Absorption
d No analysis made

e FAA - Flameless Atomic Absorption
f AA - Atomic Absorption
g CC - Colorimetric
h Ct - Activity counting

Source: Resource Data, Resources Company, October 1974.

FIGURE II-26

Trace Element Analysis of Roof and Floor Rock
Samples from Coal Beds in the Kaiparowits Project Leasehold Area [a]
(Radian Corporation Report to Resources Company - September 1974)

Element	Coal Bed - 1	Coal Bed - 2	Coal Bed - 3	Coal Bed - 4
Antimony	12.	19.	14.	16.
Arsenic	3.1	6.6	23.	.50
Beryllium	.43	.42	.39	.47
Boron	28.	36.	35.	27.
Cadmium	2.2	1.8	1.3	1.6
Chromium	99.	116.	26.	26.
Cobalt	6.5	12.	14.	7.8
Fluorine	480.	980.	990.	610.
Germanium	.39	.18	.24	.08
Lead	3.4	3.6	4.7	3.9
Mercury	.038	.073	.109	.089
Molybdenum	2.5	2.4	1.8	1.5
Nickel	16.	29.	22.	18.
Selenium	2.8	3.4	3.3	2.7
Uranium	.22	.45	.28	.17
Vanadium	20.	20.	20.	20.
Yttrium[b]	55.	71.	58.	57.

a Samples were taken to characterize the trace element content of the coal preparation reject material. All values are in ppm dry weight basis unless otherwise noted. Values represent the average of duplicate determinations.

b Part earths reported as Yttrium.

Other minerals

Several other mineral commodities occur in the area. Since 1964, oil has been produced in commercial quantity from Pre-Cretaceous rock in the Upper Valley Field towards the extreme northern part of the plateau. (Townships 35, 36 and 37 South, Ranges 1 and 2 East, Salt Lake Meridian). As of June 1974, 12,470,000 barrels had been produced from this field. Exploration in other areas of the plateau has not been productive thus far, nor have commercial quantities of natural gas been found.

Large quantities of clinker, rock baked and fused by burning of adjacent coal beds, are present in many of the canyons where coal bearing strata are exposed. Clinker is commonly used as a road surface material and as railroad ballast.

Sources of aggregate, which could be processed for asphalt and concrete mixes, or used as road subbase, fill, borrow or ballast, occur in canyon bottoms and along terraces throughout the region. Important deposits are contained in the Wahweap Creek drainage near Glen Canyon City, where sand and gravel are mined, on Horse Mountain and along the Paria River drainage.

Common clays and bentonitic mudstones occur in the area and might be suitable for lining ponds at the proposed generating station and coal washery. Clay, in beds up to 100 feet in depth, is found throughout the Tropic Shale Formation which outcrops along the base of the plateau. Bentonitic mudstone occurs as lenses within the Kaiparowits Formation capping the central and western parts of the plateau.

Limestone is common in southern Utah. Many deposits, known to be high-carbonate varieties, are suitable for chemical applications, such as stack scrubbing of SO_2 in coal-fired electric generating plants, or as mine rock dust for protection against fire and explosion propagation.

One such deposit of limestone having the desired qualities for industrial use occurs in the Wasatch Formation on the west side of Johns Valley, north of the Kaiparowits Plateau and Bryce Canyon National Park (Township 34 South, Range 3 West, Salt Lake Meridian). Other deposits are found north-northwest in the high plateau of the Wasatch Formation, in the Canaan Peak area east of Henrieville, Utah, and west in the Carmel Formation near Orderville, Utah.

Titaniferous sandstone deposits are reported in the Escalante area in the northern portion of the plateau, and in the Rees, Croten, and Sunday Canyon area in the southern sector. These deposits, occurring within the Straight Cliffs Formation, are presently noncommercial.

Early prospecting efforts in the area resulted in the discovery of a few impure deposits of copper, gold, and manganese in sedimentary rocks, but none of the minerals have proven to be of commercial grade. Extensive prospecting for uranium has been conducted, without apparent success, in various sedimentary formations in the area, including those formations which have been significant producers elsewhere on the Colorado Plateau.

Proposed town site

The geology and topography for the proposed townsite is different than the remainder of the impact area.

The proposed townsite is on East Clark Bench, one of several broad benches along the southern boundary of the Kaiparowits Plateau. At the proposed site, elevations vary from 4,000 to 4,400 feet. Topography is flat to rolling, with a general slope of 2 to 10 percent to the northeast and east toward Wahweap Creek. A number of small intermittent washes cross the proposed townsite. The largest is Buck Tank Draw with steep banks 100 feet entering Wahweap Creek. To the southwest the terrain rises abruptly onto sandstone outcrops and hills with steep escarpments.

The surface of the proposed townsite consists mostly of windblown quartz sand partially stabilized by vegetation. Sand and gravel terrace deposits, well cemented, are exposed beneath the sand along the Wahweap Creek channel. The extent of these terrace gravels beneath the townsite is unknown. Similar terraces, however, are known to underlie several hundred acres northwest of Glen Canyon City where sand and gravel pits have been established. The windblown sand extends from 2 to 20 feet or greater in depth. The terrace gravels extend to 20 feet in thickness (Waldrop and Sutton, 1966).

Sandstone bedrock of the Navajo Formation is exposed mostly to the north of the site along Coyote and Wahweap creeks and in isolated outcrops on the site. South of the site the sandstone is formed into high, smooth cliffs and domes.

Transmission system impact area

Kaiparowits to Phoenix, Kaiparowits to Eldorado, Kaiparowits to Moenkopi to Mohave

General

The Kaiparowits to Phoenix, the Kaiparowits to Eldorado, and the Kaiparowits to Moenkopi to Mohave segments of the transmission system would cross three physiographic provinces in southern Utah, northwestern Arizona, and southern Nevada (Illustration II-15). The provinces are the Plateau, the Transition Zone, and the Basin and Range, respectively. Following are the approximate mileages that would be traversed by each line in each province (Wilson, 1962):

	Plateau	Transition Zone	Basin & Range
Kaiparowits to Phoenix	219	38	42
Kaiparowits to Eldorado	142	0	127
Kaiparowits to Moenkopi to Mohave	241	28	39

The Plateau Province consists of broad, flat plateaus interrupted by small mesas or flat-topped ridges, rims and cliffs, and steep-sided canyons. Although the most dominant feature is the Grand Canyon, mountain ranges also become a dominant land form along the west boundary of the Province. Along the routes, elevations range from 3,000 to 6,500 feet. Slopes vary from near flat on plateaus and mesas to 2,000 feet per mile along rims, cliffs, and canyon walls. The entire Province is drained by the Colorado River and its tributaries which include the Virgin River, Kanab Creek, the Paria River, and the Little Colorado River. Dry washes drain large areas to these streams. Gradients along streams generally do not exceed 100 feet per mile.

Geology of the Plateau Province consists of a thick sequence of sedimentary rock, made up of interbedded shale, sandstone, conglomerate, and limestone, formed 180,000,000 to 300,000,000 years ago. The beds are generally flat-lying, but some beds dip steeply. In some areas, sedimentary rock is overlain by volcanic rock consisting of lava flows and ash beds deposited during the last million years. Deposits of silt, sand, and gravel occur along canyon bottoms. Geologic structures previously described for the plant site area are similar over the entire Plateau Province.

The Transition Zone consists of rugged mountains. As the name implies, the zone represents a change from Plateau topography to Basin and Range topography. The zone is approximately 20 miles wide through much of Arizona, ending approximatel 30 miles north of Kingman. Elevations in the Transition Zone range from 4,000 to 7,000 feet, with slopes from 500 to 1,000 feet per mile. Washes and ephemeral (short lived) streams drain the area to the west and southwest, to the Colorado River.

Rock types in the Transition Zone include the sedimentary and volcanic rocks of the Plateau Province. The oldest sedimentary rocks were deposited over one billion years ago on a crystalline basement consisting of granite, schist,

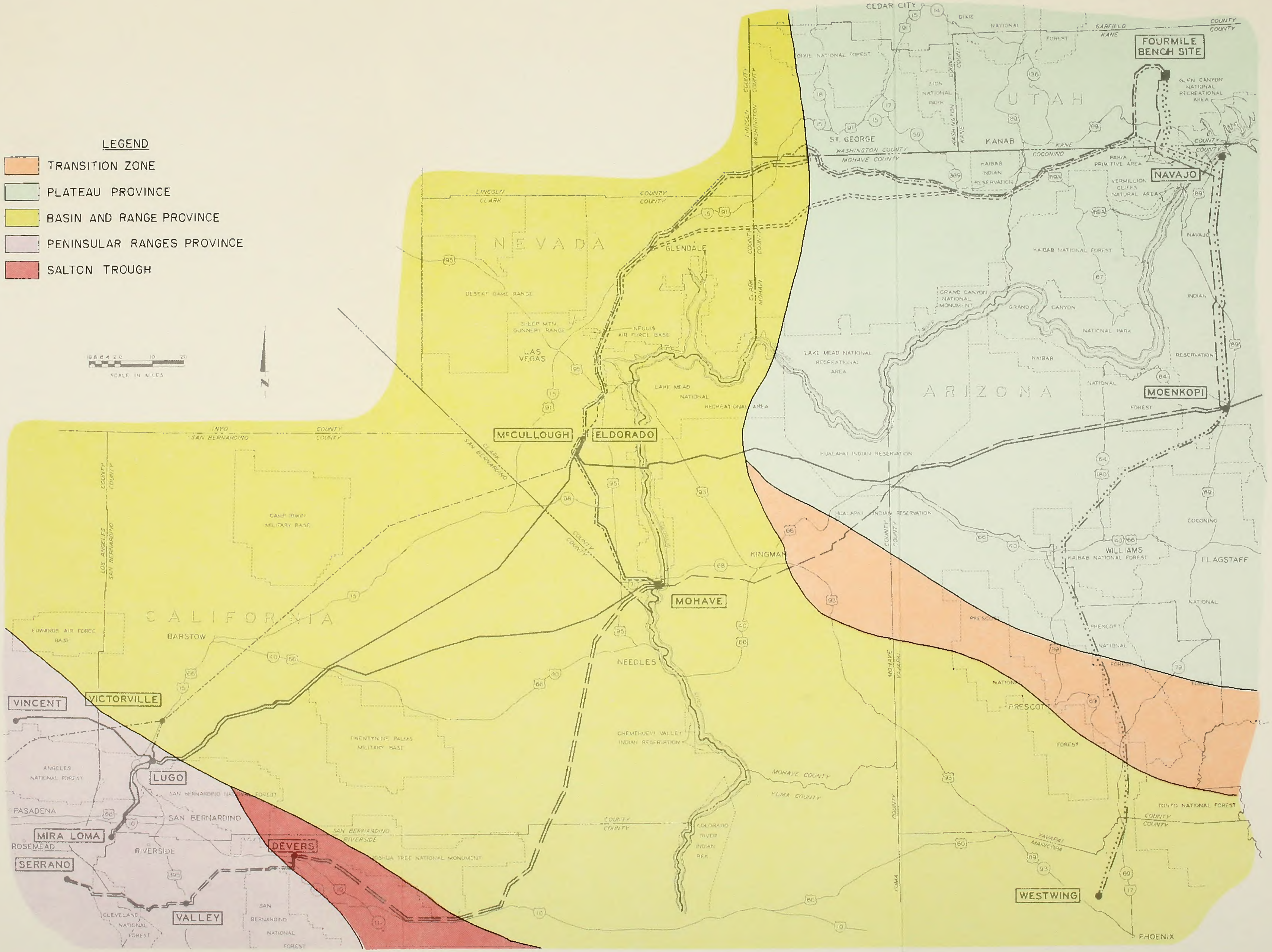


ILLUSTRATION II-15

Physiographic Provinces

and gneiss. The major structural feature of the Transition Zone are faults marked by escarpments such as the Cottonwood Cliffs and Mogollon Rim. Movement along these faults has been as much as several thousand feet.

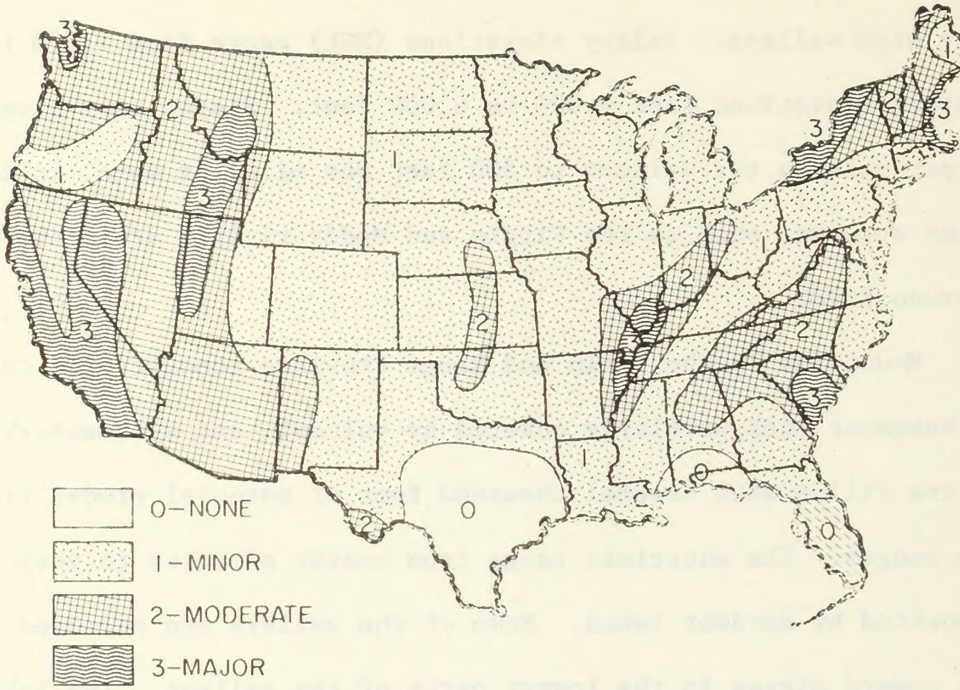
The Basin and Range Province consists of rugged mountain ranges separated by wide valleys. Valley elevations (MSL) range from 1,000 to 4,000 feet and mountain elevations from 4,000 to 6,000 feet. Slopes vary from as little as 50 feet per mile in the valleys to 500 feet per mile, or more, in the mountains. Washes and streams, such as the Virgin and Muddy rivers, drain the Province into the Colorado River.

Mountains in the Basin and Range Province consist of a core of crystalline basement rock partially covered by volcanic and sedimentary rock. Valleys are filled with several thousand feet of material eroded from adjacent mountain ranges. The materials range from coarse alluvium to very fine grained beds deposited by ancient lakes. Some of the valleys are enclosed forcing drainage toward playas in the lowest parts of the valleys. The lakes are dry most of the year. Other valleys drain into the Colorado River.

Mountain ranges in the Basin and Range Province were formed by the uplift of blocks bounded on one or both sides by faults. In most cases, uplift of these fault blocks can be measured in thousands of feet.

Seismology

The Kaiparowits to Phoenix, Kaiparowits to Eldorado, and Kaiparowits to Moenkopi to Mohave proposed segments of the transmission system cross an area of moderate seismic risk (Illustration II-16). Recorded earthquakes in northern Arizona, and in adjacent areas in Utah, southern Nevada, and southeastern California, have ranged from 5 to 8 on the Modified Mercalli Intensity Scale (Coffman, 1973). Moderate damage can be expected from such earthquakes. The Hurricane



(Coffman, 1973, p 1)

ILLUSTRATION II-16

Seismic Risk Map for Contiguous United States

fault is the only fault known to be active in this area. Information on seismic activity in this area is limited. Other active faults may be identified in the future.

Mohave to Serrano

General

The Mohave to Serrano route would cross three physiographic provinces in the southern most tip of Nevada and southern California (Illustration). The route would cross the Basin and Range Province 128 miles in a southerly direction to the Salton Trough. From that point the route would turn northwest and follow the Salton Trough for about 63 miles, then crosses the Peninsular Ranges Province in a westerly direction for 78 miles.

For the most part, the descriptions of the Basin and Range topography and geology apply to the Basin and Range Province in southern California. An exception is that the crystalline basement farther west consists of crystalline rock plus younger (70 million years) granitic rock.

The Salton Trough is a low-lying desert basin extending from the Gulf of California northwest to the San Bernardino area. The trough is bounded on both sides by rugged mountains and low hills. Elevations range from 2,000 feet near the northwest to a few hundred feet below sea level at the Salton Sea. Much of the basin is enclosed, with central drainage via dry washes and the White Water River to the Salton Sea. Slopes are gentle, not exceeding a few "tens" of feet per mile.

The Salton Trough is underlain by crystalline basement which consists of granite, gneiss and schist a billion years old, and younger granites about 70 million years old. Interbedded shale, siltstone and sandstone deposited 30 million years ago overlie the crystalline rocks. Some of the sedimentary rocks

are poorly consolidated and erosion has produced scattered Badland topography along the margins of the Trough.

The predominant structural feature of the Salton Trough is the San Andreas Fault which traverses the western edge of California, north of San Francisco, south to the Mexican border. At both ends, the fault extends into the sea. On the north it enters near Point Reyes, and on the south at the Gulf of California. The fault zone marks a strip of shattered rock up to 1/4-mile in width. Completely different rock types occur on opposite sides of the fault, suggesting a horizontal offset exceeding 300 miles in some areas.

The proposed route parallels the San Andreas Fault in the Salton Trough, and crosses it near the Devers substation. The route also crosses smaller faults branching off from the San Andreas.

The Peninsular Ranges Province consists of a series of northwest-trending mountain ranges and valleys. Rapid uplift of the mountain ranges in this area produced rugged topography. Elevations vary from about 1,000 feet in valleys to 9,000 feet in the nearby San Jacinto Mountains, with slopes ranging from a few "tens" of feet per mile to more than 1,000 feet per mile. The area is drained by creeks and rivers to the Pacific Ocean.

Rock types in the area are sedimentary, ranging in age from 30 to 150 million years, granite intrusions to 70 million years, and recent alluvium. The granite, intruded into older sedimentary rock, is covered by younger sedimentary rock. Most exposures of these rocks occur in the mountain ranges. Erosion of the mountains has produced large amounts of alluvium deposited as valley fill.

In the Peninsular Ranges Province, the proposed route crosses several active faults, most notably the San Jacinto and Elsinore faults. Offset along some faults, such as the San Jacinto, has been horizontal. Mountain ranges in this area have been uplifted to 10,000 feet by vertical displacement along faults on one or both sides.

Seismology

The Mohave to Serrano segment of the proposed tranmsission line crosses an area in southeastern California of moderate seismic risk. Near the Salton Trough, the route enters an area of major destructive earthquakes which have resulted from movement along the San Andreas and associated faults. Although intensity of quakes has ranged from 5 to 12 on the Modified Mercalli Intensity Scale (Coffman, 1973), it is not known how frequently earthquakes of a given magnitude occur.

Northern Kaiparowits to Mohave preferred alternate, Arizona Strip preferred alternate

The descriptions of topography and geology for the proposed Mohave to Serrano route also apply to the Northern Kaiparowits to Mohave preferred alternate route and to the Arizona Strip preferred alternate route. Descriptions of seismicity along the proposed Kaiparowits to Phoenix, Kaiparowits to Eldorado, and Kaiparowits to Moenkopi to Mohave routes also apply to the two preferred alternate routes.

Economic geology

Mining activity is light in most areas proposed for the transmission system and alternate systems. Sedimentary rocks of the Plateau Province have yielded helium, uranium, coal, gas, and oil. Building stone has also been mined. In the Basin and Range Province, crystalline basement, volcanic rock and lake beds have yielded a wide variety of commodities including copper, gold, silver, tungsten, mercury, iron, perlite, silica sand, lime, gypsum and salt. The proposed routes pass within a few miles of active mines at Apex and Moapa, Nevada; Kingman, Arizona; and Eagle Mountain, California.

Limestone quarry impact area

The proposed quarry area is on one of a series of limestone ridges along the western side of the broad, alluvial-filled Johns Valley. The ridges

blend smoothly with alluvium in the valley bottom. Elevations range from about 7,800 feet along the crest of the ridges to 7,400 feet in the valley. A series of intermittent streams flow southeasterly through gaps in the ridges to join the northward-flowing east fork of the Sevier River in the central valley (see Illustration I-111, Chapter I).

Soils

Kaiparowits Plateau impact area

Introduction

Soil associations depicted in Illustration II-17 were mapped from a Bureau of Land Management watershed inventory and from data compiled by the Soil Conservation Service (Wilson, et al., 1975). A more detailed soils map is included in Appendix II-4, with a glossary of soil names, tables of interpretations, terminology and description of interpretive methodology.

The watershed inventory includes data on soil acreages, present erosion condition, effective root depth, texture, percent slope and erosion susceptibility. Soil association information reveals soil depths, texture, soil color, and, in some cases, identifies the presence of rock, calcium carbonates and alkalinity. From this information, annual estimated sediment yield, probability of seeding success, water absorption rates, and engineering and construction potentials can be determined.

All soils in the study area receive 6 to 12 inches of rainfall annually and are moist for some part of the summer. Mean annual soil temperature is 47^{o} to 59^{o} F, whereas mean summer temperature is above 59^{o} F. These soils are used mainly for livestock grazing, wildlife habitat and as areas for recreation.

Deep Plateau Soils Association

The Deep Plateau Soils Association encompasses soils "A" through "N" on the soils map (Appendix II-4). This association is about 70 percent water-deposited soils, 20 percent warm-temperature soils, and 10 percent soils with higher than normal organic matter, which may or may not contain calcium carbonate. (See Appendix II-5 for technical descriptions of the soil associations.) Slopes in this association vary from nearly flat to moderately steep at an elevation of 5,000 to 7,000 feet above sea level. Rainfall varies from 10 to 12 inches a year.

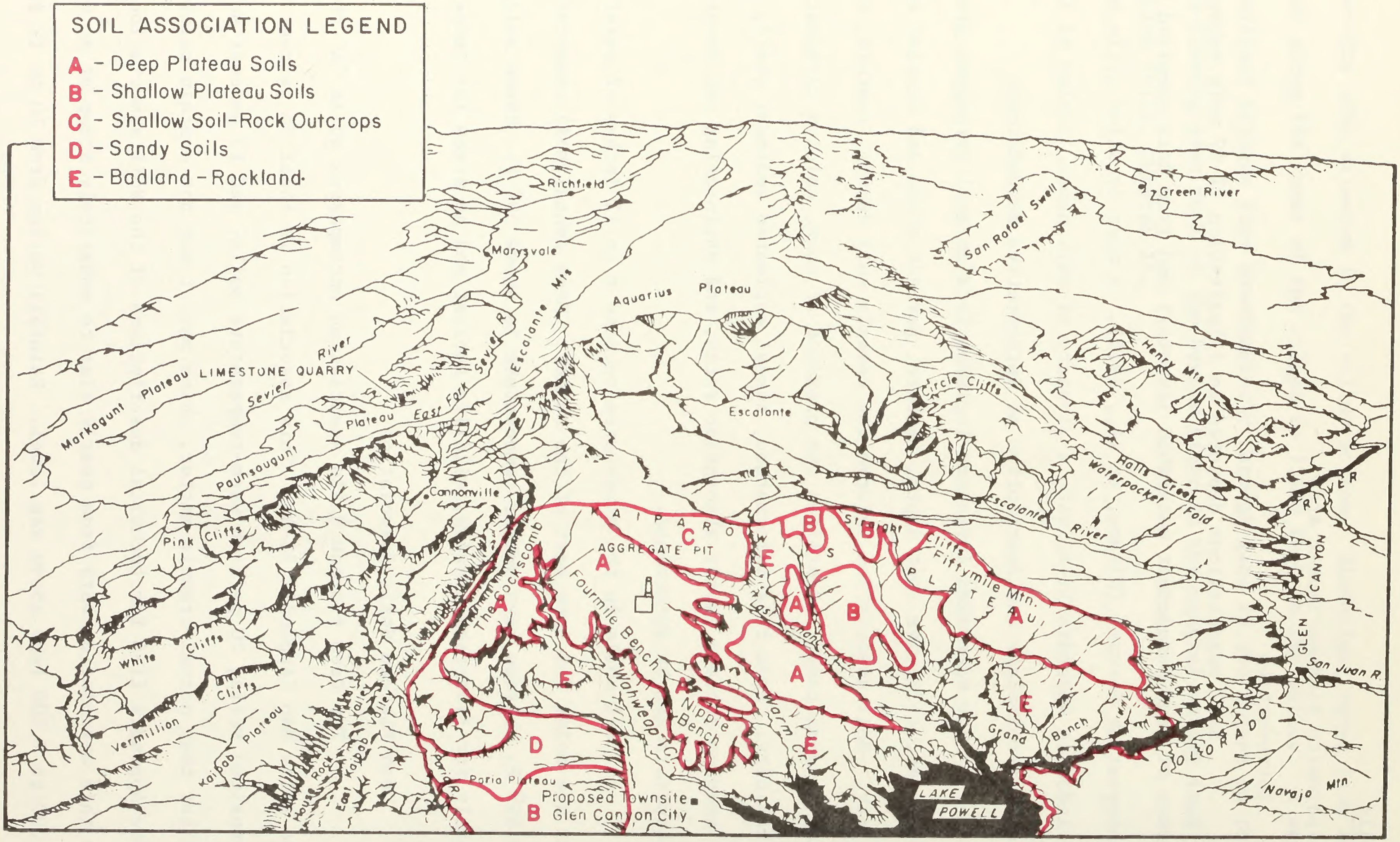


ILLUSTRATION II-17

Generalized View of the Soil Association Within Kaiparowits Impact Area
(Looking North from Utah-Arizona Line)

These soils contain small to moderate amounts of exchangeable sodium. Depth of these soils exceeds 40 inches. Surface layers exhibit colors from light brownish gray to reddish brown, with particles moderately coarse to moderately fine. Subsoil and lower lying layers consist of light reddish brown to pinkish gray particles of medium texture.

The erosion condition varies from slight to moderate, and the estimated annual sediment production ranges from 0.3 to 0.7 acre-foot per square mile. Erosion susceptibility, should vegetation be removed, would be moderate because of the unconsolidated and medium-textured nature of the soils.

These soils can absorb water at a rate of 0.5 to 3.5 inches per hour. Water will move through the soil at a rate of 0.06 to 6.0 inches per hour.

Probable annual success in reseeding disturbed areas, under otherwise natural conditions, varies from less than 3 years in 10, to 3 to 5 years in 10 (Hagihara, et al., 1972).

Shallow Plateau Soils Association

The Shallow Plateau Soils Association includes soils "O" throuth "T" on the detailed soils map. This association is 55 percent soils 10 to 20 inches deep, which may or may not contain calcium carbonate, and 45 percent soils deeper than 20 inches. Slopes vary from nearly flat to moderately steep at an elevation of 5,000 to 6,500 feet above sea level. Rainfall varies from 6 to 12 inches a year.

These soils contain small to moderate amounts of exchangeable sodium. Surface layers display colors from reddish brown to yellowish red, with particles moderately coarse in texture. Subsoil contains medium-textured soil particles varying from brown to reddish brown to yellowish red. Substrata, found only in the deeper soils, varies from brown to yellowish red, with medium to coarse textured particles. Deeper soils also display a calcium carbonate layer between 6 and 24 inches deep.

The erosion condition of the Shallow Plateau Association varies from slight to moderate, and estimated annual sediment production ranges from 0.35 to 0.7 acre-foot a square mile. Erosion susceptibility, should vegetation be removed, is moderate because of the unconsolidated and medium-textured nature of the soils.

These soils can absorb water at the rate of 0.5 to 2.0 inches per hour in the deeper layers and less than 0.5 inches per hour in the shallow soils. Water moves through these soils at the rate of 0.6 to 20.0 inches an hour.

Probable annual success in reseeding disturbed areas, under otherwise natural conditions, is less than 3 years in 10.

Shallow Soil-Rock Outcrop Association

The Shallow Soil-Rock Outcrop Association includes soils "U" and "V" on the soils map. In this association of soils some 60 percent are shallow and warm-temperature, 15 percent are rock outcrops, and the remaining 25 percent are cool-temperature, on Pleistocene and Halocene deposits and in deep and dry soils. Slopes vary from moderately steep to steep at an elevation of 5,000 to 8,000 feet. Rainfall averages from 10 to 12 inches annually.

These soils also contain small to moderate amounts of exchangeable sodium. Surface layers consist of medium to moderately-fine particles, varying from light brownish gray to light yellowish brown. Subsoil contains moderately fine particles exhibiting colors from pale brown to brownish gray. Soil depth in this association is 20 inches or less.

Erosion condition of the soil association is critical; estimated annual sediment production is from 0.6 to 1.0 acre-foot per square mile. Erosion susceptibility, should vegetation be removed, is severe because of the steep slopes and fine-textured soils.

These soils absorb water at a rate less than 0.5 inch per hour. Water can move through these soils at the rate of 0.6 to 2.0 inches an hour.

Probable annual success in reseeding disturbed areas, under otherwise natural conditions, is less than 3 years in 10.

Sandy Soils Association

The Sandy Soils Association includes soils labeled "W" on the soils map. In this association, 60 percent are sandy, 20 percent are warm-temperature, and 20 percent contain calcium carbonate. Slopes are nearly flat at an elevation of 4,400 to 5,500 feet. Rainfall varies from 6 to 10 inches annually.

These soils contain small to moderate amounts of exchangeable sodium. Surface layer, substrata and lower layers have coarse-textured, yellowish red particles.

Erosion condition of this soil association is slight; the estimated annual sediment production is from 0.3 to 0.4 acre-foot per square mile. Erosion susceptibility, should vegetation be removed, is slight because of the level slopes and coarse-textured soils.

These soils absorb water at a rate faster than 3.5 inches an hour. Water moves through these soils at the rate of 6 to 20 inches per hour.

Probable annual success in reseeding disturbed areas, under otherwise natural conditions, is 3 to 5 years in 10 years.

Badland-Rockland Association

The Badland-Rockland Association includes soils "X" through "SS" on the soils map. The association consists of 30 to 50 percent rock outcrops, 20 to 40 percent shallow and very shallow soils over sandstone bedrock, and 5 to 10 percent deep and moderately deep soils. Slopes vary from nearly level to very steep. Rainfall varies from 6 to 12 inches annually.

The erosion condition of this association is slight to critical. The estimated annual sediment production is from 0.3 to 1.5 acre-feet per square mile. Erosion susceptibility, should vegetation be removed, varies from slight

on gentler slopes with coarse textures, to severe on steeper slopes with fine textures.

These soils absorb water at a rate of 3.5 inches or less per hour. Water moves through these soils at the rate of less than 2.0 inches per hour.

Reseeding disturbed areas, under otherwise natural conditions, is highly impractical due to lack of soil and sparse rainfall - less than 8 inches a year.

Transmission system impact area

The proposed transmission system crosses five broad physiographic provinces with five types of parent material and main soil types. These provinces are described in the geology and topography section of this chapter. Factors controlling development of soils are: parent material, topography, climate, vegetation, and precipitation. These factors combine to produce what is known as a soil association - a group of soils in a geographic area. Terms used to describe a particular soil include texture, depth, structure, permeability, susceptibility (to erosion) and sediment yield.

Mapping units (e.g., "A," "B," etc.) in Appendix II-4 coincide with soil associations in the Kaiparowits Plateau impact area, described in Appendix II-5. The transmission system would start at the proposed generating station. The first 26 miles of the southern system and the first 32 miles of the western system are within this impact area. Remaining soil associations are described in Appendix II-6.

Kaiparowits to Phoenix

Mapping units for the Kaiparowits to Phoenix segment of the proposed transmission system are:

Miles	Units	
0 to 4	I	Described in Appendix II-5
4 to 6	UU	
6 to 7	II	
7 to 8	UU	
8 to 10	LL	
10 to 13	UU	
13 to 14	WW	
14 to 16	X	
16 to 17	O	
17 to 20	W	
20 to 24	O	
24 to 26	P	
26 to 31	5A	
31 to 78	4C	
78 to 80	5A	
80 to 118	4A	
118 to 141	2A	
141 to 146	1B	
146 to 156	1D	
156 to 170	1B	
170 to 172	1A	
172 to 176	1D	
176 to 206	1A	
206 to 208	10	
208 to 225	8	
225 to 237	7	
237 to 246	11	
246 to 249	4	
249 to 251	11	
251 to 259	7	
259 to 267	4	
267 to 283	13	
283 to 301	4D	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

Twenty-three soil associations are found along this proposed route. The following chart shows the soil units with erosion hazard and rehabilitation potential. Appendix II-6 describes the basis for erosion hazard and rehabilitation potential.

Soil Unit	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
I	4	1.4	Moderate	Low
UU	6	1.9	Severe	Low
II	1	.4	Moderate	Low
LL	2	.6	Moderate	Low
WW	1	.4	Moderate	Low
X	2	.6	Moderate	Medium
O	5	1.6	Moderate	Medium
W	3	1.1	Moderate	Medium
P	2	.6	Low	Low
5A	7	2.3	Low	Low
4C	47	15.6	Severe	Low
4A	38	12.6	Severe	Low
2A	23	7.7	Moderate	Low
1B	19	6.3	Low	Medium
1D	14	4.7	Severe	High
1A	32	10.6	Moderate	Medium
10	2	.7	Moderate to Severe	Medium
8	17	5.6	Moderate to Severe	Medium
7	20	6.6	Moderate to Severe	Medium
11	11	3.7	Moderate	Medium
4	11	3.7	Severe	Medium
13	16	5.3	Severe	Low
4D	18	6.0	Moderate	Low

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	38	9.3	Low	165	54.8
Moderate	102	33.9	Medium	122	40.5
Moderate to Severe	39	12.9	High	14	4.7
Severe	132	43.9			

Kaiparowits to Navajo

Mapping units for the Kaiparowits to Navajo segment of the proposed transmission system are:

Miles	Units	
0 to 4	I	Described in Appendix II-5
4 to 6	UU	
6 to 7	II	
7 to 8	UU	
8 to 10	LL	
10 to 13	UU	
13 to 14	WW	
14 to 16	X	
16 to 17	O	
17 to 20	W	
20 to 24	O	
24 to 26	P	
26 to 31	5A	
31 to 47	4C	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

The 11 soil associations found along this proposed route are described in Appendix II-6. The following chart shows the soil units:

Soil Unit	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
I	4	5	Moderate	Low
UU	6	12.7	Severe	Low
II	1	2.1	Moderate	Low
LL	2	4.3	Moderate	Low
WW	1	2.1	Moderate	Low
X	2	4.3	Moderate	Medium
O	5	10.6	Moderate	Medium
W	3	6.4	Moderate	Medium
P	2	4.3	Low	Low
5A	5	10.6	Low	Low
4C	16	34.1	Severe	Low

Summary

Erosion Hazard

	Miles	Percent
Low	7	14.9
Moderate	18	38.3
Severe	22	46.8

Rehabilitation Potential

	Miles	Percent
Low	37	78.7
Medium	10	21.3

Twenty-three soil associations are found along this proposed route. The following chart shows the soil units with erosion hazard and rehabilitation potential. Appendix II-6 describes the basis for erosion hazard and rehabilitation potential.

Soil Unit	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
I	4	1.4	Moderate	Low
UU	6	1.9	Severe	Low
II	1	.4	Moderate	Low
LL	2	.6	Moderate	Low
WW	1	.4	Moderate	Low
X	2	.6	Moderate	Medium
O	5	1.6	Moderate	Medium
W	3	1.1	Moderate	Medium
P	2	.6	Low	Low
5A	7	2.3	Low	Low
4C	47	15.6	Severe	Low
4A	38	12.6	Severe	Low
2A	23	7.7	Moderate	Low
1B	19	6.3	Low	Medium
1D	14	4.7	Severe	High
1A	32	10.6	Moderate	Medium
10	2	.7	Moderate to Severe	Medium
8	17	5.6	Moderate to Severe	Medium
7	20	6.6	Moderate to Severe	Medium
11	11	3.7	Moderate	Medium
4	11	3.7	Severe	Medium
13	16	5.3	Severe	Low
4D	18	6.0	Moderate	Low

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	38	9.3	Low	165	54.8
Moderate	102	33.9	Medium	122	40.5
Moderate to Severe	39	12.9	High	14	4.7
Severe	132	43.9			

Kaiparowits to Navajo

Mapping units for the Kaiparowits to Navajo segment of the proposed transmission system are:

Miles	Units	
0 to 4	I	Described in Appendix II-5
4 to 6	UU	
6 to 7	II	
7 to 8	UU	
8 to 10	LL	
10 to 13	UU	
13 to 14	WW	
14 to 16	X	
16 to 17	O	
17 to 20	W	
20 to 24	O	
24 to 26	P	
26 to 31	5A	
31 to 47	4C	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

The 11 soil associations found along this proposed route are described in Appendix II-6. The following chart shows the soil units:

Soil Unit	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
I	4	5	Moderate	Low
UU	6	12.7	Severe	Low
II	1	2.1	Moderate	Low
LL	2	4.3	Moderate	Low
WW	1	2.1	Moderate	Low
X	2	4.3	Moderate	Medium
O	5	10.6	Moderate	Medium
W	3	6.4	Moderate	Medium
P	2	4.3	Low	Low
5A	5	10.6	Low	Low
4C	16	34.1	Severe	Low

Summary

Erosion Hazard

	Miles	Percent
Low	7	14.9
Moderate	18	38.3
Severe	22	46.8

Rehabilitation Potential

	Miles	Percent
Low	37	78.7
Medium	10	21.3

Kaiparowits to Moenkopi to Mohave

Mapping units for the proposed Kaiparowits to Moenkopi to Mohave segment are:

Miles	Units	
0 to 4	I	
4 to 6	UU	
6 to 7	II	
7 to 8	UU	
8 to 10	LL	
10 to 13	UU	Described in Appendix II-5.
13 to 14	WW	
14 to 16	X	
16 to 17	O	
17 to 20	W	
20 to 24	O	
24 to 26	P	
26 to 31	5A	
31 to 78	4C	
78 to 80	5A	
80 to 121	4A	
121 to 178	2A	
178 to 180	3A	
180 to 183	2A	
183 to 188	3A	
188 to 194	1A	
194 to 198	3A	
198 to 201	2A	
201 to 203	8	
203 to 212	4B	
212 to 218	8	
218 to 225	5	
225 to 228	8	
228 to 230	15	
230 to 233	5	
233 to 237	1	
237 to 239	4	
239 to 244	6	
244 to 246	5	
246 to 255	1	
255 to 265	2	
265 to 271	1	
271 to 276	2	
276 to 283	6	
283 to 309	3	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

Twenty-four soil associations found along the proposed route are described in Appendix II-6. The following chart shows the soil units:

Soil Units	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
I	4	1.3	Moderate	Low
UU	6	1.9	Severe	Low
II	1	.3	Moderate	Low
LL	2	.7	Moderate	Low
WW	1	.3	Moderate	Low
X	2	.6	Moderate	Medium
O	5	1.6	Moderate	Medium
W	3	1.0	Moderate	Medium
P	2	.7	Low	Low
5A	7	2.3	Low	Low
4C	47	15.3	Severe	Low
4A	41	13.3	Severe	Low
2A	63	20.4	Moderate	Low
3A	11	3.6	Moderate	Medium
1A	6	1.9	Moderate	Medium
8	11	3.5	Moderate to severe	Medium
4B	9	2.9	Moderate	High
5	12	3.9	Moderate	Low
15	2	.7	Moderate	Low
1	19	6.2	Moderate	Low
4	2	.7	Severe	Medium
6	12	3.9	Moderate	Low
2	15	4.9	Moderate	Low
3	25	8.1	Low	Low

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	34	11.0	Low	259	84.1
Moderate	167	54.2	Medium	40	13.0
Moderate to Severe	11	3.6	High	9	2.9
Severe	96	31.2			

Kaiparowits to Moenkopi to Mohave

Mapping units for the proposed Kaiparowits to Moenkopi to Mohave segment are:

Miles	Units	
0 to 4	I	Described in Appendix II-5.
4 to 6	UU	
6 to 7	II	
7 to 8	UU	
8 to 10	LL	
10 to 13	UU	
13 to 14	WW	
14 to 16	X	
16 to 17	O	
17 to 20	W	
20 to 24	O	
24 to 26	P	
26 to 31	5A	
31 to 78	4C	
78 to 80	5A	
80 to 121	4A	
121 to 178	2A	
178 to 180	3A	
180 to 183	2A	
183 to 188	3A	
188 to 194	1A	
194 to 198	3A	
198 to 201	2A	
201 to 203	8	
203 to 212	4B	
212 to 218	8	
218 to 225	5	
225 to 228	8	
228 to 230	15	
230 to 233	5	
233 to 237	1	
237 to 239	4	
239 to 244	6	
244 to 246	5	
246 to 255	1	
255 to 265	2	
265 to 271	1	
271 to 276	2	
276 to 283	6	
283 to 309	3	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

Twenty-four soil associations found along the proposed route are described in Appendix II-6. The following chart shows the soil units:

Soil Units	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
I	4	1.3	Moderate	Low
UU	6	1.9	Severe	Low
II	1	.3	Moderate	Low
LL	2	.7	Moderate	Low
WW	1	.3	Moderate	Low
X	2	.6	Moderate	Medium
O	5	1.6	Moderate	Medium
W	3	1.0	Moderate	Medium
P	2	.7	Low	Low
5A	7	2.3	Low	Low
4C	47	15.3	Severe	Low
4A	41	13.3	Severe	Low
2A	63	20.4	Moderate	Low
3A	11	3.6	Moderate	Medium
1A	6	1.9	Moderate	Medium
8	11	3.5	Moderate to severe	Medium
4B	9	2.9	Moderate	High
5	12	3.9	Moderate	Low
15	2	.7	Moderate	Low
1	19	6.2	Moderate	Low
4	2	.7	Severe	Medium
6	12	3.9	Moderate	Low
2	15	4.9	Moderate	Low
3	25	8.1	Low	Low

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	34	11.0	Low	259	84.1
Moderate	167	54.2	Medium	40	13.0
Moderate to Severe	11	3.6	High	9	2.9
Severe	96	31.2			

Kaiparowits to Eldorado

Mapping units for the proposed Kaiparowits to Eldorado segment are:

Miles	Units	
0 to 3	E	
3 to 4	U	
4 to 5	E	
5 to 6	LL	
6 to 7	B	
7 to 8	D	
8 to 10	B	Described in Appendix II-5
10 to 13	D	
13 to 17	N	
17 to 18	K	
18 to 23	UU	
23 to 25	D	
25 to 29	W	
29 to 32	O	
32 to 44	2A	
44 to 64	4A	
64 to 67	2A	
67 to 83	9	
83 to 104	4B	
104 to 108	9	
108 to 112	2A	
112 to 113	9	
113 to 116	1	
116 to 121	9	
121 to 132	2	
132 to 142	14	
142 to 147	8	
147 to 173	2	
173 to 193	18	
193 to 196	19	
196 to 207	18	
207 to 239	2	
239 to 253	18	
253 to 268	20	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

Twenty-one soil associations found along this proposed route were described previously. The following chart shows the soil units:

Soil Units	Miles	% of line	Erosion Hazard	Rehabilitation Potential
E	4	1.5	Moderate	Medium
U	1	.4	Severe	Low
LL	1	.4	Moderate	Low
B	3	1.1	Moderate	Medium
D	6	2.2	Moderate	Medium
N	4	1.5	Moderate	Low
K	1	.4	Moderate	Medium
UU	5	1.9	Severe	Low
W	4	1.5	Moderate	Medium
O	3	1.1	Moderate	Medium
2A	19	7	Moderate	Low
4A	20	7	Severe	Low
9	26	10	Moderate	Low
4B	21	8	Moderate	High
1	3	1	Moderate	Low
2	69	25	Moderate	Low
14	10	4	Moderate	Low
8	5	2	Moderate to Severe	Medium
18	45	17	Moderate	Low
19	3	1	Moderate	Low
20	15	6	Moderate	Low

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	0	0	Low	226	84
Moderate	237	88	Medium	21	8
Moderate to Severe	5	2	Medium	21	8
Severe	26	10			

Mohave to Serrano

The proposed Mohave to Serrano transmission line crosses three physiographic provinces: Basin and Range, Salton Trough, and Peninsula Ranges. These provinces are described in the geology and topography section of this chapter.

General soil maps and interpretations for the proposed Mohave to Serrano segment of the transmission system were not available for this report. Only broad soils groups are used in the route description.

Miles	Groups
0 to 2	Alluvial and desert soils (aridisols) (see Figure II-27).
2 to 8	Mixed alluvial (aridisols), lithosols and rockland (entisols).
8 to 72	Alluvial, desert, red desert, and sierozem soils (aridisols).
72 to 77	Solonchak and solonetz soils (aridisols).
77 to 80	Lithosols and rockland (entisols).
80 to 97	Alluvial and calcisol soils (aridisols).
97 to 104	Lithosols and rockland (entisols).
104 to 111	Alluvial, desert, and red desert soils and regosols (aridisols and entisols).
111 to 114	Rockland and lithosols (entisols).
114 to 127	Alluvial, desert, and sierozem, and regosols (aridisols and entisols).
127 to 130	Solonchak and solonetz (aridisols).
130 to 149	Alluvial and desert soils, calcisols, lithosols, and regosols (aridisols and entisols).
149 to 151	Lithosols and rockland (entisols).
151 to 164	Alluvial soils (aridisols).
164 to 180	Lithosols and rockland (entisols).
180 to 187	Alluvial soils and regosols (aridisols and entisols).
187 to 202	Alluvial and desert soils (entisols and aridisols).
202 to 217	Lithosols and rockland (entisols).
217 to 220	Noncalcic brown soils (alfisols).
220 to 227	Granitic rockland and lithosols.
227 to 233	Alluvial noncalcic brown and noncalcic brown hardpan (alfisols).
233 to 241	Lithosols and noncalcic brown soils (entisols and alfisols).
241 to 243	Noncalcic brown soils (alfisols).
243 to 246	Lithosols (entisols).

FIGURE II-27

Present Soil Orders and Approximate Equivalents

Present Order	Approximate Equivalents
Entisols	Azonal soils, and some low humic gley soils.
Vertisols	Grumusols
Inceptisols	Ando, sol brun acide, some brown forest, low-humic gley, and humic gley soils.
Aridisols	Desert, reddish desert, sierozem, solonchak, some brown and reddish-brown soils, and associated solonetz.
Mollisols	Chestnut, chernozem, brunizem (prairie), rendzinas, some brown, brown forest, and associated solonetz and humic gley soils.
Spodosol	Podzols, brown podzolic soils, and ground water podzols.
Alfisols	Gray-brown podzolic, gray wooded soils, non-calic brown soils, degraded chernozem, and associated planosols and some half-bog soils.
Ultisols	Red-yellow podzolic soils, reddish-brown lateritic soils of the U. S., and associated planosols and half-bog soils.
Oxisols	Laterite soils, latosols
Histosols	Bog soils

Miles	Groups
246 to 254	Noncalcic brown (alfisols) and alluvial (entisols).
254 to 260	Alluvial (entisols) and noncalcic brown (alfisols) intermixed with small areas of chestnut (mollisols) and grumusols (vertisols).
260 to 267	Lithosols (entisols).
267 to 275	Chernozem, brunizem, rendiana, and lithosols (mollisols).

Mileages are approximate.

Soil characteristics (permeability, water-holding capacity, erosion hazard, revegetation potential, etc.) for this area were not available. Using knowledge of similar areas, however, interpretations were made for these soils.

Areas crossed by the proposed line from Mohave substation southwest to the Devers substation and west to San Gorgonio Pass have a very low potential for revegetation due to the large percentage of coarse-textured soils and low annual precipitation. Coarse-textured soils have a very low water-holding capacity to support plant growth. Approximately 197 miles of the proposed route are in this zone. The erosion hazard is high, due to wind and convective summer storms. The rehabilitation potential is low.

The remaining 70 miles of the proposed route are over fine-textured soils with good water-holding capacities and higher annual precipitation. This area has a low erosion hazard and medium-to-high rehabilitation potential.

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	70	26	Low	197	94
Moderate to Severe	197	74	Moderate to High	20	26

Northern Kaiparowits to Mohave preferred alternate

Mapping units for the proposed Northern Kaiparowits to Mohave preferred alternate route are:

Miles	Units
0 to 3	E
3 to 4	U
4 to 5	E
5 to 6	LL
6 to 7	B
7 to 8	D
8 to 10	B
10 to 13	D
13 to 17	N
17 to 18	K
18 to 23	UU
23 to 25	D
25 to 29	W
29 to 32	O
32 to 44	A
44 to 64	4A
64 to 67	2A
67 to 83	9
83 to 104	4B
104 to 108	9
108 to 112	2A
112 to 113	9
113 to 116	1
116 to 121	9
121 to 132	2
132 to 142	14
142 to 147	8
147 to 173	2
173 to 193	18
193 to 196	19
196 to 207	18
207 to 239	2
239 to 253	18
253 to 276	20
276 to 293	18
293 to 316	20
316 to 324	18
324 to 327	20

Described in Appendix II-5

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

Twenty-one soil associations crossed by this proposed route were described previously. The following chart shows the soil units:

Soil Unit	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
E	4	1.2	Moderate	Medium
U	1	.3	Severe	Low
LL	1	.3	Moderate	Low
B	3	.9	Moderate	Medium
D	6	1.9	Moderate	Medium
N	4	1.2	Moderate	Low
K	1	.3	Moderate	Medium
UU	5	1.6	Severe	Low
W	4	1.2	Moderate	Medium
O	3	.9	Moderate	Medium
2A	19	5.8	Moderate	Low
4A	20	6.1	Severe	Low
9	26	7.9	Moderate	Low
4B	21	6.4	Moderate	High
1	3	.9	Moderate	Low
2	69	21.1	Moderate	Low
14	10	3.1	Moderate	Low
8	5	1.6	Moderate to Severe	Medium
18	70	21.4	Moderate	Low
19	3	.9	Moderate	Low
20	49	15.0	Moderate	Low

Summary

Erosion Hazard

	Miles	Percent
Low	0	0
Moderate	296	90.5
Moderate to Severe	5	1.6
Severe	26	7.9

Rehabilitation Potential

	Miles	Percent
Low	285	87.2
Medium	21	6.4
High	21	6.4

Arizona Strip preferred alternate

Mapping units for the proposed Arizona Strip preferred alternate route are:

Miles	Units	
0 to 3	E	
3 to 4	U	
4 to 5	E	
5 to 6	LL	
6 to 7	B	
7 to 8	D	
8 to 10	B	Described in Appendix II-5.
10 to 13	D	
13 to 17	N	
17 to 18	K	
18 to 23	UU	
23 to 25	D	
25 to 29	W	
29 to 32	O	
32 to 44	2A	
44 to 64	4A	
64 to 67	2A	
67 to 83	9	
83 to 91	4B	
91 to 102	21	
102 to 108	2A	
108 to 113	9	
113 to 143	2A	
143 to 146	21	
146 to 149	15	
149 to 151	2	
151 to 153	15	
153 to 163	2	
163 to 165	19	
165 to 172	16	
172 to 183	19	
183 to 194	18	
194 to 226	2	
226 to 240	18	
240 to 263	20	
263 to 280	18	
280 to 298	20	
298 to 306	18	
306 to 309	20	

Mileages are approximate, taken from SCS soils maps, scales 1:600,000 and 1:633,600.

The 21 associations found along the proposed route were described previously. The following chart shows the soil units:

Soil Unit	Miles	% of Line	Erosion Hazard	Rehabilitation Potential
E	4	1.3	Moderate	Medium
U	1	.3	Severe	Low
LL	1	.3	Moderate	Low
B	3	1.0	Moderate	Medium
D	6	1.9	Moderate	Medium
N	4	1.3	Moderate	Low
K	1	.3	Moderate	Medium
UU	5	1.6	Severe	Low
W	4	1.3	Moderate	Medium
O	3	1.0	Moderate	Medium
2A	51	16.5	Moderate	Low
4A	20	6.5	Severe	Low
9	21	6.8	Moderate	Low
4B	8	2.6	Moderate	High
21	14	4.5	Moderate	Medium
15	5	1.6	Moderate	Low
2	44	14.2	Moderate	Low
19	13	4.2	Moderate	Low
16	7	2.3	Moderate	Low
18	50	16.3	Moderate	Low
20	44	14.2	Moderate	Low

Summary

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	0	0	Low	266	86.1
Moderate	283	91.6	Medium	35	11.3
Severe	26	8.4	High	8	2.6

Summary

Below is a summary of soil units that would be traversed by the proposed transmission lines: Kaiparowits to Phoenix; Kaiparowits to Navajo; Kaiparowits to Moenkopi to Mohave; and Kaiparowits to Eldorado.

Soil Unit	Miles	Soil Unit	Miles
I	12	1A	38
UU	23	10	2
II	3	8	33
LL	7	7	20
WW	3	11	11
X	6	4	13
O	18	13	16
W	13	40	18
P	6	3A	11
E	4	4B	30
U	1	5	12
B	3	15	2
D	6	1	22
K	1	6	12
N	4	2	83
5A	19	3	25
4C	110	9	26
4A	99	14	10
2A	105	18	45
1B	19	19	3
1D	14	20	15

Total - 42 Units
923 Miles

Below is a summary of soil units that would be traversed by the proposed Kaiparowits to Phoenix, Kaiparowits to Navajo, Kaiparowits to Eldorado, and Northern Kaiparowits to Mohave preferred alternate lines.

Soil Unit	Miles	Soil Unit	Miles
I	8	1B	19
UU	22	1D	14
II	2	1A	32
LL	6	10	2
WW	2	8	27
X	4	7	20
O	16	11	11
W	14	4	11
P	4	13	16
E	8	4D	18
U	2	4B	42
B	6	1	6
D	12	2	137
K	2	9	52
N	8	14	20

(Continued)

Soil Unit	Miles	Soil Unit	Miles
5A	12	18	115
4C	63	19	6
4A	78	20	64
2A	61		

Total - 37 Units
942 Miles

Below is a summary of soil units that would be traversed by the proposed Kaiparowits to Phoenix, Kaiparowits to Navajo, and the Arizona Strip alternate lines.

Soil Unit	Miles	Soil Unit	Miles
I	8	1B	19
UU	22	1D	14
II	2	1A	32
LL	6	10	2
WW	2	8	17
X	4	7	20
O	16	11	11
W	14	4	11
P	4	13	16
E	8	40	18
U	2	4B	16
B	6	15	10
D	12	2	88
K	2	9	42
N	8	18	75
5A	12	19	26
4C	63	20	55
4A	78	21	28
2A	125	16	14

Total - 38 Units
908 Miles

Following are summaries of the erosion hazards and rehabilitation potential of lands crossed by the proposed transmission lines:

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	122	11.8	Low	748	72.3
Moderate	488	47.2	Medium	243	23.5
Moderate to Severe	253	24.4	High	44	4.2
Severe	172	16.6			

The Northern Kaiparowits to Mohave preferred alternate:

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	97	10.8	Low	650	72.4
Moderate	397	44.2	Medium	213	23.7
Moderate to Severe	242	26.9	High	35	3.9
Severe	162	18.1			

The Arizona Strip preferred alternate:

Erosion Hazard	Miles	Percent	Rehabilitation Potential	Miles	Percent
Low	97	11.0	Low	632	71.8
Moderate	385	43.8	Medium	226	25.7
Moderate to Severe	236	26.8	High	22	2.5
Severe	162	18.4			

Communication sites

All existing and proposed communication sites for the proposed project are (or would be) on high ridges and mountain peaks. These areas are mostly rocky, with thin or almost no soils. The erosion hazard is low except for some poorly-constructed access roads to existing sites. Revegetation potential on most of the sites is low, due to the coarse, cobbly texture of the thin soils.

Limestone quarry impact area

Soils in the limestone quarry impact area are part of the High Mountain Soil Association. These soils receive annual precipitation between 12 and 16

inches. Much of this comes as snow from October to April. These soils are usually moist, with an average summer soil temperature of less than 59° F. The climate is characterized by cool summers and cold winters, causing the soil surface to freeze part of the year.

The High Mountain Soil Association varies from shallow to moderately deep, and is neutral to moderately acid. Surface layers are brown to very dark grayish brown loams, silt loams, and clay loams. The subsoils are brown and reddish brown fine-loamy, loamy-skeletal, and clayey-skeletal.

The erosion potential of this soil association varies from slight to moderate, and the estimated annual sediment production ranges from 0.35 to 0.5 acre-foot per square mile. Erosion susceptibility, should vegetation be removed, is moderate because of the medium textured soils.

The soils in the High Mountain Association are moderately to excessively drained. Water moves through these soils at the rate of 0.06 to 20 inches per hour. These soils can absorb water at the rate of 0.5 to 3.5 inches per hour.

Probable annual success in reseeding disturbed areas, under otherwise natural conditions, is better than 7 years in 10 (Hagihara, et al., 1972).

This High Mountain Soil Association provides for grazing, water production, wildlife habitat, recreational areas, summer home sites and timber production.

Water Resources

Utah water allocations

Compacts and treaty

The Colorado River compact of 1922 apportioned the use of 7.5 million acre-feet of water per year from the Colorado River system to the Upper Basin, and 7.5 million acre-feet a year to the Lower Basin in perpetuity. The compact requires that the Upper Basin states assure for any 10-year period an average flow of 7.5 million acre-feet annually at Lees Ferry, Arizona. The compact also recognizes the right of Mexico to water from the system. The water treaty of 1944 with Mexico further defined the right of Mexico to water from the Colorado River, guaranteeing to Mexico 1.5 million acre-feet annually.

In the Upper Colorado River Basin Compact of 1948, Utah was apportioned 23 percent of the surface water available to the Upper Basin, after the use of no more than 50,000 acre-feet a year by Arizona. Colorado, New Mexico and Wyoming were apportioned 51.75, 11.25 and 14 percent respectively of the water apportioned to the Upper Basin.

The purpose of the Colorado River Storage Project Act of 1956 was to provide for long-term storage, allowing the Upper Basin states to use their apportioned water, while still assuring that they meet delivery obligations at Lees Ferry. The act also provided for generation of hydroelectric power, flood control, recreational development, and fish and wildlife conservation. The act authorized the construction of main-stem storage units such as Glen Canyon Dam, and 11 other projects. Glen Canyon Dam was completed in 1963 and water began storing in Lake Powell. Six of the other projects have been completed, one has been cancelled, three are under construction and one has not yet been started.

Allocation and availability

Controversy exists over the question of the amount of water available to t states of the Upper Basin. The differences stem from interpretations of the various compacts and from the changes in the long-term average flow since 1922 when the Colorado River Compact was negotiated.

Compact allocation - 7.5 level

The Colorado River Compact (1922) and the Upper Colorado River Basin Compact (1948), granted Utah 23 percent of the water available each year to the Upper Basin, after a deduction of not more than 50,000 acre-feet per year for Arizona. At the time the Upper Colorado River Basin Compact was signed, it was estimated that Utah's share would be 1.7 million acre-feet. This assumed the availability of 7.5 million acre-feet for Upper Basin use annually.

State studies - 6.3 level

In 1965 the Upper Colorado River Commission sponsored a study to determine water supply of the Colorado River, and its availability to states of the Upper Basin and to Arizona, California and Nevada in the Lower Basin. The consulting firm of Tipton and Kalmbach Incorporated, Denver, Colorado, performed the study. The firm's report, July 1965, contains the following:

> "With the active storage capacity available to the Upper Basin, including reservoirs of the Upper Colorado River Storage Project now operating or under construction, beneficial consumptive use (depletion at Lees Ferry) in the Upper Colorado River Basin, including reservoir evaporation, is limited to 6.3 million a/f (maf) per annum, because of the required delivery in successive 10-year periods of 75 maf in accordance with the terms of the Compact. The net depletion, excluding reservoir evaporation, would be 5.6 maf.
>
> If deliveries at Lees Ferry are greater than 7.5 maf per year (75 maf in successive 10-year periods) to insure more power generation and financial support for the Upper Basin development, the net depletion at Lees Ferry by Upper Basin development would be less than the amounts indicated above. These depletions are less than 7.5 maf apportioned to the Upper Basin which, in turn, are less than the ultimate total requirements of the Upper Basin."

The Upper Basin states have generally maintained that at least the 6.3 million acre-feet is available for their annual use, and deliveries at Lees Ferry in excess of 7.5 million acre-feet annually are made only for the purpose of power production to enhance the financial support for Upper Basin development. Utah's share (23 %) of a 6.3 million acre-feet level is 1,438,000 acre-feet.

Bureau of Reclamation studies - 5.8 level

The Bureau of Reclamation has made extensive studies of the Colorado River Basin, considering various conditions imposed by the "laws of the river," to determine a 5.8 million acre-feet annual limit of use in the Upper Basin. Current studies by the Bureau of Reclamation assume 750,000 acre-feet at Lees Ferry each year for delivery to Mexico, in addition to an aggregate of 75 million acre-feet over each 10 year period for Lower Basin use. Other assumptions include operation of the reservoirs through the most critical low-flow period of record (1931-64), capacity of the reservoir system remaining after sediment accumulation through year 2030, utilization of bank storage for a portion of water delivered, evaporation from main-stem reservoirs consistent with the other assumptions, and allowance for shortages to irrigation users during subnormal years.

It must be recognized that Reclamation's figure of 5.8 million acre-feet as a limit of Upper Basin use is only valid under the assumptions indicated. Other sets of assumptions, particularly those associated with downstream deliveries, the period of years used for water supply and system operation, future condition of reservoirs due to sediment accumulation, the distribution of uses (i.e., irrigation, industrial, export), and the future years to which uses are projected - all of which would affect the amount of water available. Reduction of the delivery requirement at Lees Ferry would increase the water available for use in the Upper Basin by far the greatest amount. Other adjustments could either increase or decrease the supply by a smaller but substantial annual amount. It is

likely that estimates of water supply in the Colorado River will always fall within a range of values, rather than on a single quantity.

Based on the Bureau of Reclamation estimate of 5.8 million acre-feet available in the Upper Basin states, and the 23 percent allotted to Utah, the estimated Colorado River water annually available for Utah would not be more than 1.32 million acre-feet.

Kaiparowits Plateau impact area

Hydrologic system

The hydrologic system in the Kaiparowits Plateau impact area is shown in Illustration II-18. Water enters the system as precipitation, subsurface inflow from the west, and bank storage during the rising stages of Lake Powell. Water leaves the system by evapotranspiration, overland runoff, and subsurface outflow to Lake Powell (chiefly during the falling lake stages). Principal water sources for large-scale development in the area are Lake Powell and aquifers in the Navajo Sandstone.

Ground water

Ground water occurs at varying depths in virtually all the rock underlying the impact area. Quantitative estimates of the main components of the ground water system are given in Figure II-28. Principal areas of ground water recharge, selected ground water data sites, and general direction of ground water movement are shown in Illustration II-19.

Depth to the regional water table ranges from less than 100 feet beneath land surface in the lower Wahweap, Warm, and Last Chance Creek areas to more than 1,000 feet beneath higher benches such as Fourmile and Nipple benches, and Smoky Mountain. Beneath the higher benches, however, are shallower perched bodies of ground water (Illustration II-18) which can be penetrated by wells before the regional water table is reached. Data collected during exploratory core drilling

in the coal lease areas indicate that the principal coal beds are above the regional water table, but one or more perched ground water bodies may occur above or within these beds.

The perched aquifers are chiefly fine to medium-grained sandstone that yield water slowly (generally less than 1 to about 20 gallons per minute to springs and small-diameter core holes). These aquifers discharge naturally to alluvium in the bottoms of larger streams and appear as stream flow, such as the Fourmile and Tommy Waters. Alluvium receiving flow from these perched aquifers is highly permeable and may yield water readily to wells, sumps, or infiltration galleries. In most places, however, this alluvium is too thin and limited to support large continuous withdrawals of water.

The most extensive and productive aquifers in the Kaiparowits Plateau impact area are in the Navajo Sandstone where that formation extends beneath the regional water table. The Navajo Sandstone lies at great depths (2,000 to 4,000 feet) beneath Fourmile and Nipple benches and has not been tapped by wells in those areas. In the lower Wahweap Creek area, where the formation is exposed or just below the surface, several wells have been drilled which reportedly yield several hundred to more than 1,000 gallons per minute.

Ground water sampled in the Kaiparowits Plateau impact area and analyzed by the U.S. Geological Survey (Illustration II-20 and Figure II-29) ranges from fresh to moderately saline according to the following classification used by the U.S. Geological Survey:

Class	Dissolved solids (milligrams per liter)
Fresh	0 - 1,000
Slightly saline	1,000 - 3,000
Moderately saline	3,000 - 10,000
Very saline	10,000 - 35,000
Briny	More than 35,000

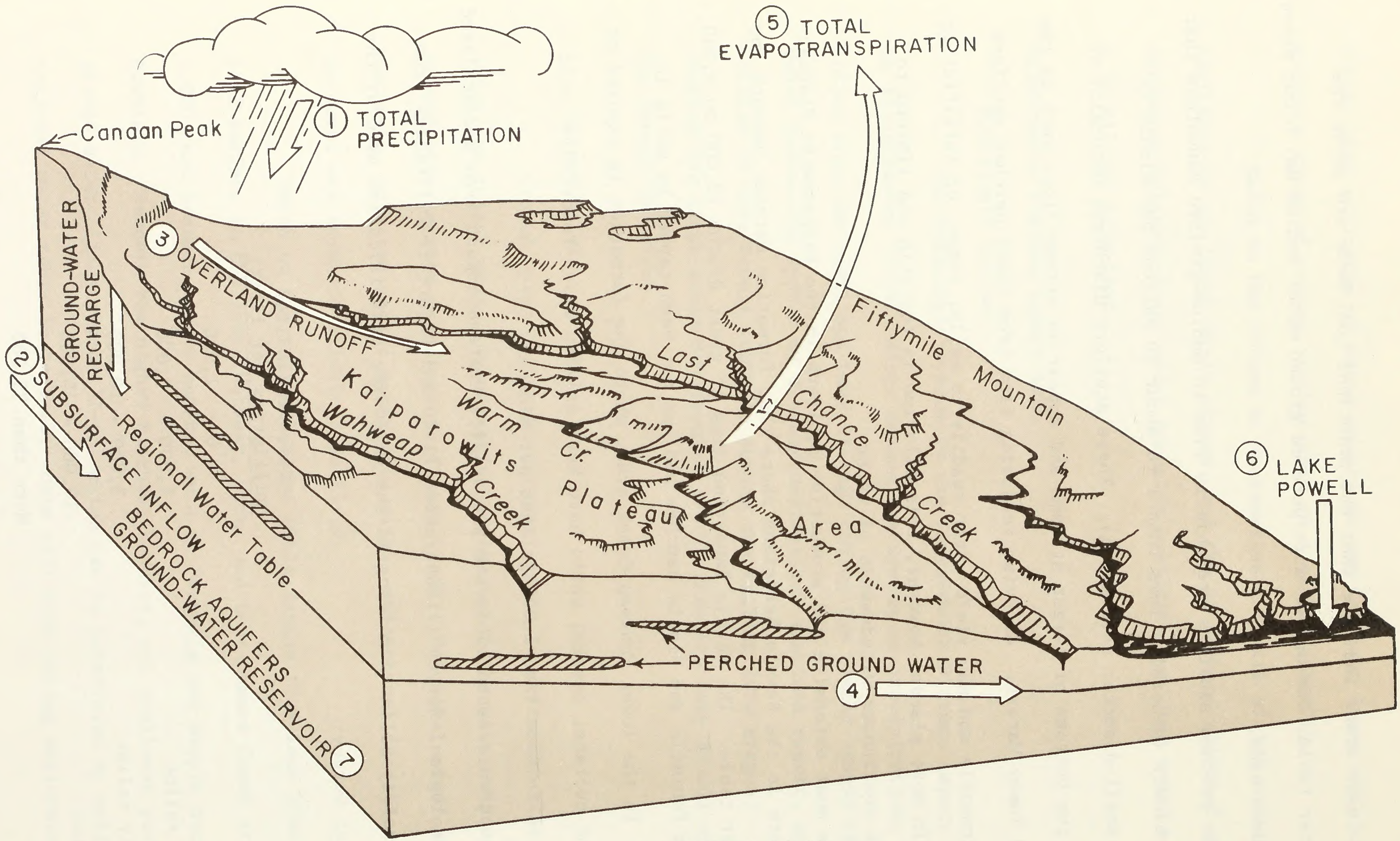


ILLUSTRATION II-18

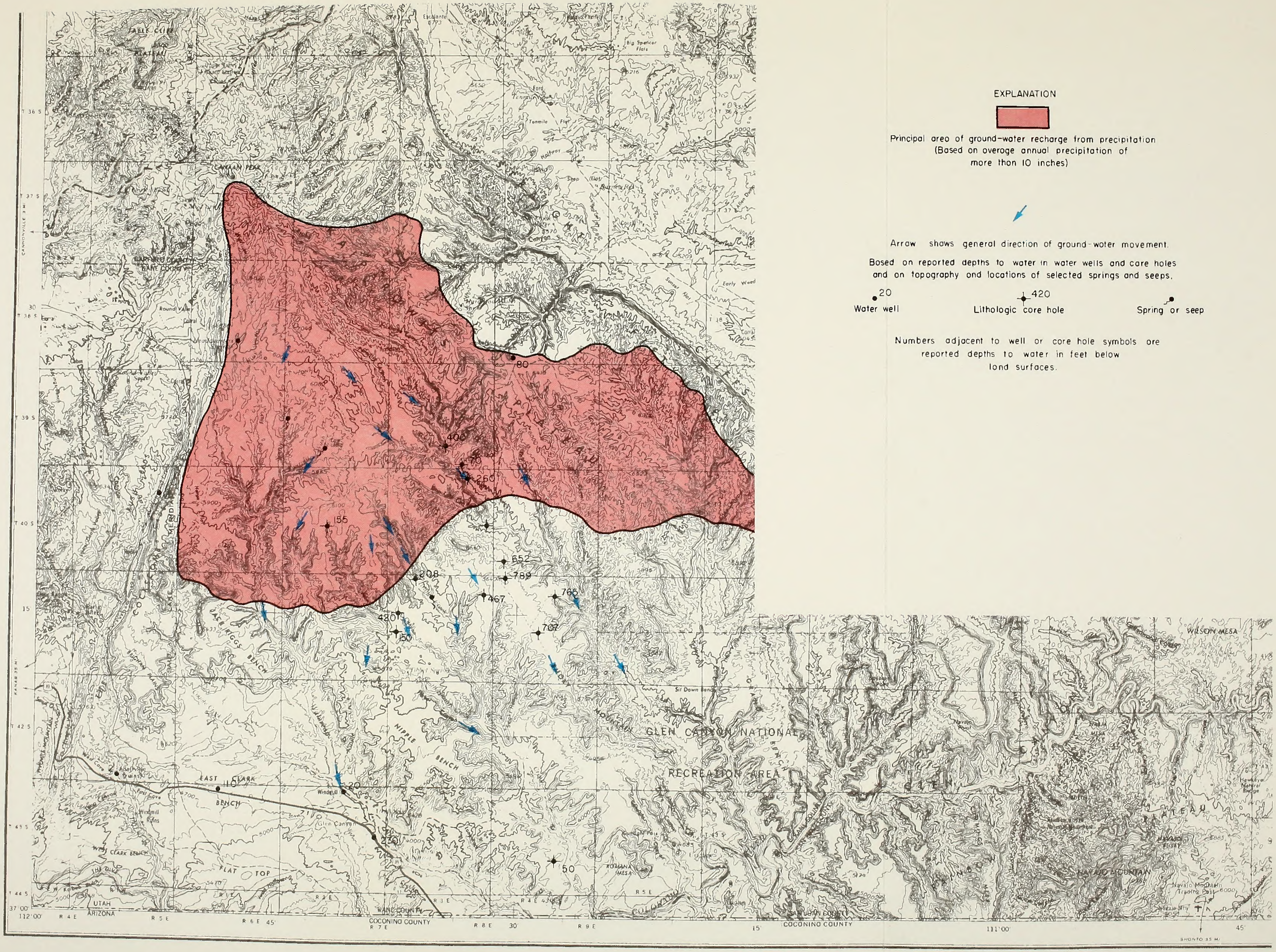
Basic Components of Hydrologic System
Kaiparowits Plateau Impact Area

FIGURE II-28

Quantitative Estimates

1.	Precipitation	Average 710,000 acre-feet/year
2.	Subsurface inflow[a]	
3.	Overland runoff	Average 6,000 acre-feet/year
4.	Subsurface outflow[a]	
5.	Evapotranspiration[b]	Average 700,000 acre-feet/year
6.	Lake Powell:	
	Usable storage	25-million acre-feet
	Average annual inflow[c]	12.86-million acre-feet/year
7.	Ground water reservoir:	
	Recoverable ground in storage[d]	800,000 acre-feet
	Natural recharge from precipitation on the impact area	Average 30,000 acre-feet/year
	Withdrawals by wells	Average less than 500 acre-feet/year

[a] Unknown but probably less than 15,000 acre-feet/year.
[b] Total consumptive use of ground and surface water in impact area; excludes evaporation from Lake Powell.
[c] Forty-nine-year average flow of Colorado River at Lees Ferry, Arizona, prior to completion of Glen Canyon Dam.
[d] Upper 100 feet of saturated rocks only.



EXPLANATION

Principal area of ground-water recharge from precipitation (Based on average annual precipitation of more than 10 inches)

Arrow shows general direction of ground-water movement.

Based on reported depths to water in water wells and core holes and on topography and locations of selected springs and seeps.

20 Water well

420 Lithologic core hole

Spring or seep

Numbers adjacent to well or core hole symbols are reported depths to water in feet below land surfaces.

ILLUSTRATION II-19

Principal Area of Ground Water Recharge

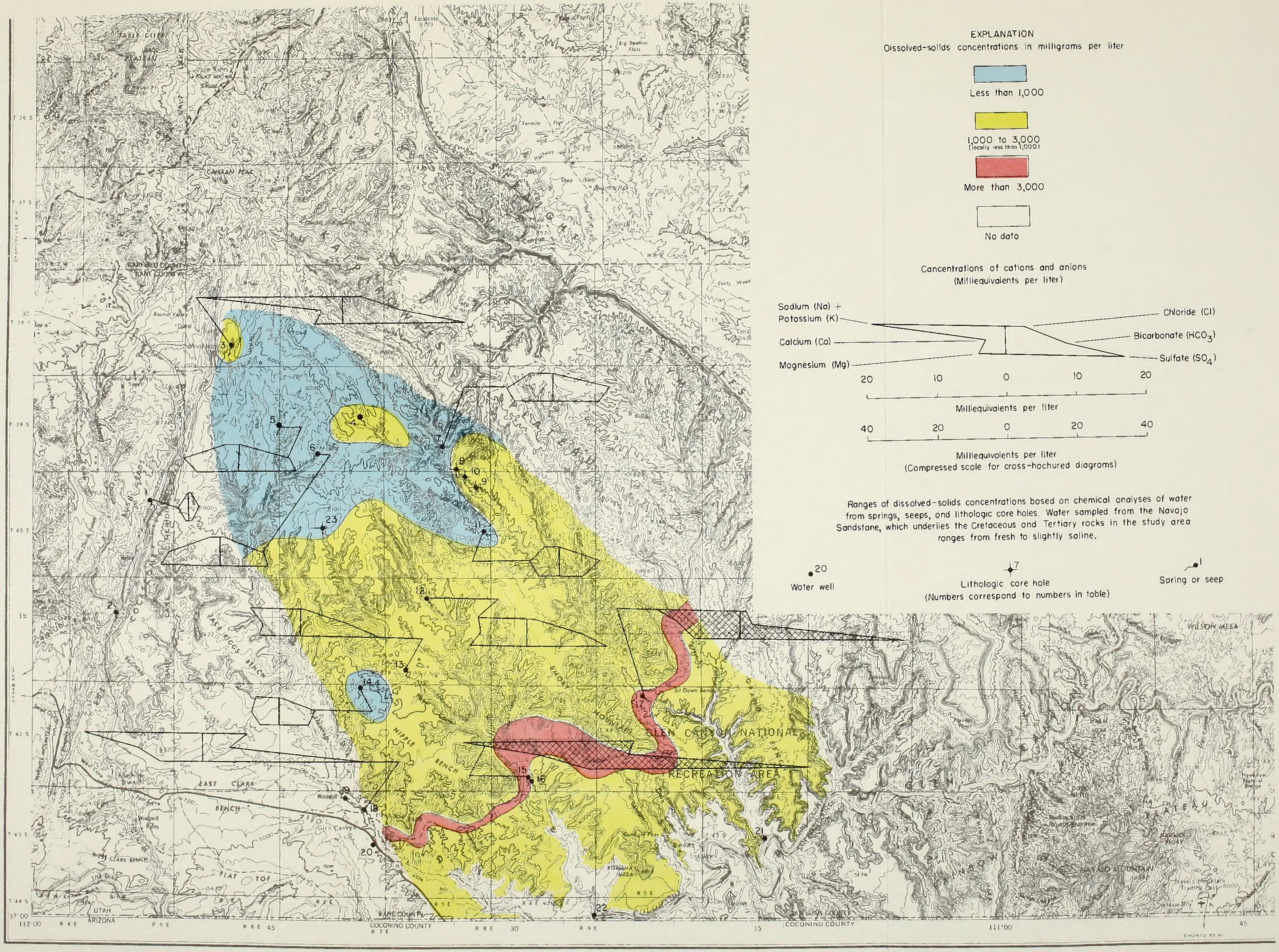


ILLUSTRATION II-20

Chemical Quality of Water

FIGURE II-29

Chemical Analysis of Water in the Kaiparowits Plateau Impact Area

Number on Illustration II-20	Name	Geologic Source[a]	Discharge[b] (ft^3/s)	Date of Collection	Temperature (°C)	Measurements (mg/ℓ): Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cℓ)	Fluoride (F)	Nitrate (NO_3)+ Nitrate (NO_2) as Nitrogen	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Iron (Fe)	Manganese (Mn)	Dissolved Solids	Hardness as ($CaCO_3$)	Noncarbonate Hardness as ($CaCO_3$)	Specific Conductance (µmho/cm at 25° C)	Sodium Adsorption Ratio	pH
1	PUMP CANYON SPRING	Jn	.03e	5-29-74	15.0	11	29	7.9	5.9	2.0	100	0	25	6.4	0.2	0.95	_	0.09	.030	.040	.010	141	110	23	236	0.3	7.9
2	COTTONWOOD CREEK	-	-	5-30-74	-	11	200	100	140	6.3	348	0	840	44	0.4	0.03	_	0.03	.150	.020	.670	1510	910	630	1980	2.0	7.8
3	HEADQUARTERS SPRINGS	Kra	.004m	5-29-74	13.0	12	58	45	490	1.4	493	0	840	92	0.7	0.03	_	0.03	.170	.010	0	1780	330	0	2610	12	8.2
4	UNNAMED SEEP	Kra	.03e	5-29-74	11.0	9.1	180	110	210	4.7	467	0	860	42	0.2	0.04	_	0.03	.110	.050	.040	1650	900	520	2180	3.0	7.7
5	TOMMY WATER	Kwa	.03m	5-29-74	11.5	9.0	160	72	40	3.1	450	0	400	15	0.1	0.02	_	0.00	.040	.140	.070	921	700	330	1320	0.7	7.7
6	FOURMILE WATER	Kwa	.03m	5-29-74	-	9.6	150	67	44	3.2	390	0	340	16	0.1	0.06	_	0.03	.050	.040	.140	823	650	330	1180	0.8	7.6
7	EL PASO NAT. GAS CO. CORE HOLE	Kst	.03r	4- 4-74	-	9.2	130	65	72	9.4	504	0	320	10	1.1	0.01	_	0.00	.350	0	.038	866	590	180	1290	1.3	7.1
8	EL PASO NAT. GAS CO. CORE HOLE	Kst	-	4-30-74	-	11	21	4.4	480	19	1310	0	10	31	7.3	0.00	_	0.03	.650	.340	0	1230	71	0	1950	25	7.4
9	EL PASO NAT. GAS CO. CORE HOLE	Kst	-	4-30-74	-	11	50	22	380	15	1180	0	97	22	3.9	0.03	_	0.03	.560	.250	.010	1180	220	0	1860	11	7.3
10	EL PASO NAT. GAS CO. CORE HOLE	Kst	-	4-30-74	-	11	25	5.7	530	22	1490	0	6.4	33	7.5	0.00	-	0.00	.710	.030	0	1380	86	0	2170	25	7.2
11	DRIP TANK	Kst	.09e	5-30-74	-	11	85	39	44	5.8	367	0	160	4.1	0.4	0.03	-	0.00	.160	.030	.080	531	370	72	837	1.0	8.0
12	WESSES SPRING	Kst	-	5-14-74	-	8.4	130	97	150	8.6	486	0	560	34	0.4	0.12	-	0.06	.270	-	-	1230	720	330	1770	2.4	7.5
13	TABBET SPRING	Kst	-	5-30-74	-	15	110	73	160	9.8	411	0	550	22	0.5	0.10	-	0.06	.250	.010	.010	1140	580	240	1600	2.9	7.7
14	NIPPLE SPRING	Kst	-	5-30-74	-	11	79	35	73	5.0	317	0	210	7.5	0.4	0.005	-	0.00	.100	0	.010	578	340	81	908	1.7	8.0
15	WARM CREEK	-	.01e	5-29-74	-	17	400	80	980	20	323	0	2800	250	1.1	0.28	-	0.06	.670	.020	.070	4710	1300	1100	5840	12	7.8
16	UNNAMED SPRING	Je	-	5-30-74	-	11	21	6.0	580	7.4	481	13	750	120	5.4	0.33	-	0.00	.860	.360	0	1750	77	0	2640	29	8.7
17	LAST CHANCE CREEK	-	.03e	5-31-74	-	17	340	160	500	24	217	0	2300	71	0.9	0.06	-	0.06	.590	.040	.180	3520	1500	1300	4160	5.6	8.0
18	WAHWEAP CREEK	-	1.0e	5-31-74	-	8.1	190	77	400	9.6	230	0	1100	240	0.5	0.49	-	0.00	.270	.020	.030	2140	790	600	3040	6.2	8.0'
19	WATER WELL	Jn	3.6r	5-31-74	20.0	14	110	58	160	12	331	0	400	140	0.4	0.53	-	0.03	.150	.030	0	1060	510	240	1610	3.1	7.8
20	WATER WELL	Jn	.06r	10-9-63	19.0	9.3	15	15	[c] 71	-	190	0	71	16	-	-	0.3	-	-	1.40	-	292	98	0	477	3.1	7.4
21	LAST CHANCE CREEK	-	.5m	10-6-48	-	22	105	40	[c] 48	-	242	-	310	7.1	-	-	.4	-	-	-	-	652	426	228	918	1.0	-
			1.0m	9-12-57	-	17	150	39	[c] 63	-	200	-	444	30	-	-	2.8	-	-	-	-	844	534	370	1,190	1.2	7.9
22	WARM CREEK	-	2.5m	10-7-48	-	17	131	36	[c] 178	-	332	-	300	197	-	-	.9	-	-	-	-	1,020	475	203	1,580	3.6	-
	WAHWEAP CREEK[d]	-	6.6m	9-26-47	-	16	92	47	[c] 126	-	329	-	249	119	-	-	.4	-	-	-	-	812	423	154	1,260	2.7	-
			7.6m	10-7-48	-	14	99	49	[c] 122	-	350	-	255	113	-	-	1.6	-	-	-	-	826	448	162	1,290	2.5	-
	COLORADO RIVER[e]	-	-	-f	-	-	76	26	80	-	161	-	252	56	-	-	-	-	-	-	-	588	295	161	882	2.0	7.8

[a]Geologic Source: Je-Entrada Sandstone; Jn-Navajo Sandstone; Kra-Kaiparowits Formation; Kwa-Wahweap Sandstone; Kst-Straight Cliffs Sandstone

[b]Discharge: e-estimated; m-measured; r-reported.

[c]Sodium plus potassium calculated and reported as sodium.

[d]Sampling site at confluence with Colorado River about 3 miles downstream from Utah-Arizona state line.

[e]Sampling site at Lees Ferry, Arizona, 28 miles downstream from Utah-Arizona line, and 16 miles from Glen Canyon Dam

[f]Values are discharge-weighted averages for water years 1965-72, representing general chemical quality of regulated outflow from Lake Powell.

Four ground water samples collected in the spring of 1974 and analyzed by the participants contained the following concentrations of heavy metals and trace elements.

Constituents	Sampled Source (mg/ℓ)			
	Tommy Water[a]	Fourmile Water	Drill hole 2[b]	Drill hole 10[b]
Arsenic	0.008	0.004	0.002	0.003
Barium	0.05	0.05	0.05	0.05
Cadmium	0.03	0.01	0.01	0.05
Chronium (total)	0.01	0.005	0.02	0.42
Copper	0.007	0.03	0.03	0.42
Cyanide	0.005	0.005	0.005	0.005
Lead	0.01	0.04	0.13	0.58
Mercury	0.002	0.001	0.001	0.001
Selenium	0.006	0.002	0.001	0.005
Zinc	0.08	0.04	0.50	4.98

[a] Sample from ponded water; constituents probably concentrated by evaporation.

[b] Located on Fourmile Bench in area of proposed generating station.

Most of the ground water is chemically suitable for industrial uses such as dust control, road construction, and coal washing. However, most of the water sampled is very hard and may not be satisfactory for cooling or for boiler feed without pre-softening. Also, the generally high concentration of dissolved solids suggests that most of the ground water may be unsatisfactory (unless pretreated) for other industrial processes requiring high quality water.

Quality standards for potable water used by public carriers and other standards subject to federal quarantine regulations are established by the U.S. Public Health Service (U.S. Public Health Service, 1962). These standards concern bacteria, radioactivity, and chemical constituents which may be objectionable in a water supply. Standards for selected constituents analyzed in Figure II-29 with Health Service recommended limits are:

"The following chemical substances should not be present in a water supply in excess of the listed concentrations where .... other more suitable supplies are or can be made available."

Substance	Recommended Limit (mg/ℓ)
Arsenic (As)	0.01
Chloride (Cℓ)	250
Copper (Cu)	1.0
Cyanide (CN)	0.01
Fluoride (F)	[a]1.2
Iron (Fe)	.3
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Zinc (Zn)	5.0
Dissolved solids	500

[a]Optimum value based on the annual average of maximum daily air temperature of 69° F at Kanab, Utah.

"The presence of the following substances in excess of the concentrations listed shall constitute grounds for rejection of the supply.

Substance	Concentration (mg/ℓ)
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Hex valent) (Cr^{+6})	0.05
Cyanide (CN)	0.2
Lead (Pb)	0.05
Selenium (Se)	0.01

According to the analyses in Figure II-29, the concentration of dissolved solids, sulfate, and chloride in most of the waters sampled exceeds limits recommended by the U.S. Public Health Service for drinking water. In some areas, however, waters containing total dissolved solids and some specific constituents exceeding the limits are used for drinking because of a lack of better water. Of the available analyses of trace elements and heavy metals, only lead (from the two drill holes on Fourmile Bench) exceeded the maximum allowable concentration recommended by the U.S. Public Health Service.

The principal chemical characteristics affecting the usefulness of water for irrigation are: total concentration of soluble salts; relative proportion of sodium to other cations (positively charged irons); concentration of boron or other constituents that may be toxic to some plants; and bicarbonate concentration in excess of the concentration of calcium plus magnesium. The U.S. Agricultural Research Service salinity laboratory staff at Riverside, California, has devised a method for classifying water for irrigation use by plotting data on conductivity

versus sodium absorption ratio (SAR). The diagram (Figure II-30) classifies the water into 16 categories, ranging from low sodium-low salinity hazard to very high sodium-very high salinity hazard. This method of classification is based on "average conditions" with respect to soil texture, infiltration rate, drainage, quantity of water used, climate, and salt tolerance of crops.

Most of the ground water sampled in the Kaiparowits Plateau impact area is in a low sodium-high salinity hazard category and is, therefore, acceptable for irrigation. However, the concentration of boron in some of the samples exceeds the tolerance limit of certain boron-sensitive plants such as legumes.

The State of Montana (McKee and Wolf, 1963) rates water for livestock as follows:

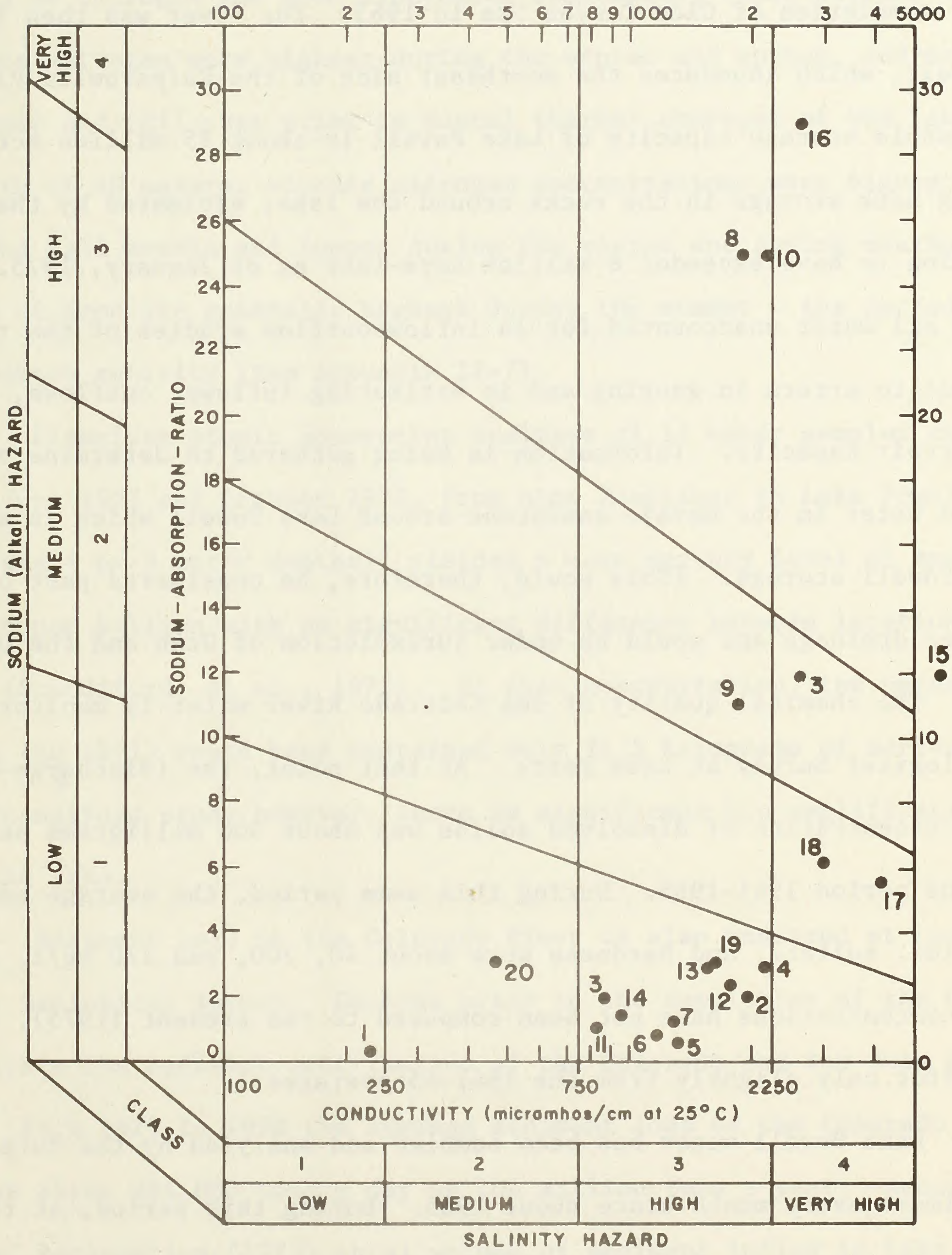
Rating	Dissolved solids (mg/ℓ)
Good	Less than 2,500
Fair	2,500 - 3,500
Poor	3,500 - 4,000
Unfit	More than 4,500

According to this classification, most of the ground water sampled in the Kaiparowits Plateau impact area is acceptable for livestock. Most of the water is also used by wildlife, apparently without adverse effect.

Those sampled springs and seeps considered chemically suitable for public supply are also considered chemically suitable for recreation supply (drinking water at campsites or rest areas). However, the water would probably not be biologically suitable without treatment, unless the springs and seeps were developed in a closed system to prevent contamination of the water.

FIGURE II-30

Classification of Water for Irrigation
in Kaiparowits Plateau Area



NOTE: Numbers correspond to numbers in Illustration II-20.

Surface water

The Colorado River is the only perennial stream (stream that runs all year) in the Kaiparowits Plateau impact area. The average annual discharge recorded at Lees Ferry, Arizona, was 12.96 million acre-feet per year for 49 years prior to completion of Glen Canyon Dam in 1963. The river was then impounded in Lake Powell, which inundates the southeast side of the Kaiparowits Plateau impact area. Usable storage capacity of Lake Powell is about 25 million acre-feet, excluding bank storage in the rocks around the lake, estimated by the Bureau of Reclamation to have exceeded 8 million acre-feet as of January, 1975. This figure includes all water unaccounted for in inflow-outflow studies of the reservoir. It is subject to errors in gauging and in estimating inflows, outflows, evaporation, and reservoir capacity. Information is being gathered to determine the percentage of ground water in the Navajo sandstone around Lake Powell which is actually part of Lake Powell storage. (This would, therefore, be considered part of the Colorado River drainage and would be under jurisdiction of Utah and the United States.)

The chemical quality of the Colorado River water is monitored by the U.S. Geological Survey at Lees Ferry. At that point, the (discharge-weighted) average concentration of dissolved solids was about 500 milligrams per liter (mg/ℓ) during the period 1941-1965. During this same period, the average concentrations of chloride, sulfate, and hardness were about 40, 200, and 270 mg/ℓ, respectively. Average concentrations have not been computed to the present (1975), but probably would differ only slightly from the 1941-65 averages.

Lake Powell water has been sampled and analyzed by the Bureau of Reclamation almost every month since about 1965. During this period, at the Wahweap Bay sampling site, the minimum, shallow-water concentration of total dissolved solids averaged about 550 mg/ℓ while the maximum, deep-water concentration averaged about 815 mg/ℓ. Approximate average maximum concentrations of major constituents in the water in (mg/ℓ) are calcium (100), magnesium (35), sodium (110), bicarbonate (190), chloride (80) and sulfate (360).

Data were collected from June 1972 to May 1973 by Northern Arizona University (Blim, et al., 1973) on various physio-chemical characteristics that affect the biological quality of water in the Warm Creek and Wahweap bays of Lake Powell. During the period when the data were collected, concentrations of such nutrients as nitrogen and iron fluctuated seasonally. Near-surface concentrations of nitrate nitrogen were highest during the winter and spring, and were lowest in late summer and fall just prior to annual thermal overturn of the lake. Conversely, at a depth of 40 meters, nitrate nitrogen concentrations were highest during summer and fall months and lowest during the winter and spring months. Concentrations of iron are generally highest during the summer - the period of highest phytoplankton activity (See Appendix II-7).

Flameless atomic absorption analyses of 12 water samples collected between June 1971 and October 1972, from nine locations in Lake Powell (including surface and 4 or 5 meter depths), yielded a mean mercury level of approximately 0.01 part per billion with no significant difference between locations and depths sampled (Standiford, et al., 1973). At this concentration, the upper 5 meters of the lake (in 1971) would have contained only 21.5 kilograms of mercury. According to the Standiford study however, there is significant bio-amplification of mercury within the lake.

Sediment load in the Colorado River is also measured at Lees Ferry by the U.S. Geological Survey. Records prior to the completion of the Glen Canyon Dam indicate the sediment contribution of the Colorado and San Juan Rivers to Lake Powell. From 1929 to 1958 the average sediment load of the Colorado River at Lees Ferry was about 284,000 tons a day or 104 million tons a year. According to the Bureau of Reclamation (1973) total volume of sediment inflow to Lake Powell averages about 91,000 acre-feet a year.

With regard to criteria for ground water, the water stored in Lake Powell is chemically suitable for most industrial, agricultural, wildlife, and

recreational uses. The water would require some treatment for drinking and for use in some industrial processes that require soft, high quality water.

All streams that rise in the Kaiparowits Plateau are intermittent, that is, they run for only part of the year. The largest are Wahweap, Last Chance and Warm creeks, which together drain nearly 85 percent of the plateau and probably have perennial flow in their lower reaches during most years. Several miscellaneous measurements and estimates of discharge have been made by the U.S. Geological Survey near the mouths of the three streams. The data are as follows:

Stream	Date	Discharge (cubic feet per second)
Wahweap Creek	10-17-46	7.8
	6-29-47	6.0
	9-26-47	6.6
	10-7-48	7.6
Warm Creek	10-16-46	.4 (estimated)
	6-29-47	1.2
	9-26-47	1.4 (estimated)
	10-7-48	2.5
Last Chance Creek	10-16-46	.6 (estimated)
	9-25-47	.4 (estimated)
	10-6-48	.5
	9-12-57	1.0

Based on channel geometry characteristics (Moore, 1968), mean annual runoff from Warm Creek is estimated at about 1,000 acre-feet a year, and from Wahweap Creek at least 2,000 acre-feet a year. Since these two streams together drain approximately half of the Kaiparowits Plateau, there are probably another

3,000 acre-feet discharged annually by the remaining streams (primarily Last Chance Creek). Thus, total mean annual runoff in all intermittent streams from the plateau is estimated to be about 6,000 acre-feet.

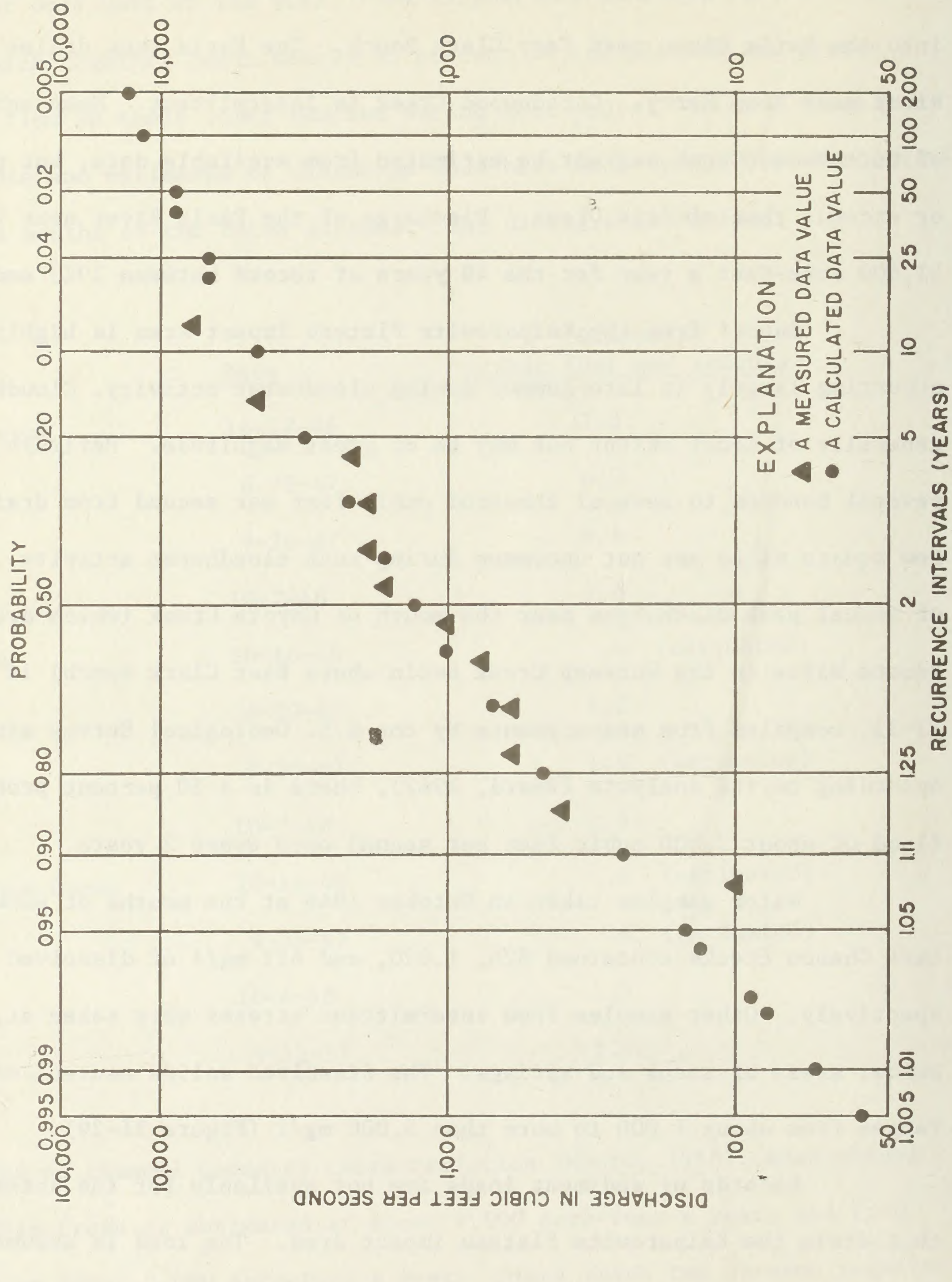
Cottonwood Creek drains that part of the impact area west of the plateau into the Paria River near East Clark Bench. The Paria then drains into the Colorado River near Lees Ferry. Cottonwood Creek is intermittent. Mean annual discharge of Cottonwood Creek can not be estimated from available data, but probably equals or exceeds that of Warm Creek. Discharge of the Paria River near Lees Ferry averaged 21,600 acre-feet a year for the 49 years of record between 1923 and 1972.

Runoff from the Kaiparowits Plateau impact area is highly variable, occurring largely in late-summer during cloudburst activity. Cloudburst floods are generally of local extent but may be of great magnitude. Periodic discharges of several hundred to several thousand cubic feet per second from drainages of only a few square miles are not uncommon during such cloudburst activity. The magnitude of annual peak discharges near the mouth of Coyote Creek (which drains about 90 square miles in the Wahweap Creek Basin above East Clark Bench) is shown in Figure II-31, compiled from measurements by the U.S. Geological Survey since 1959. According to the analysis (Beard, 1962), there is a 50 percent probability of a flood of about 2,000 cubic feet per second once every 2 years.

Water samples taken in October 1948 at the mouths of Wahweap, Warm and Last Chance creeks contained 826, 1,020, and 652 mg/ℓ of dissolved solids, respectively. Other samples from intermittent streams were taken at, or immediately below, areas of seeps and springs. The dissolved-solids content of these samples ranges from about 1,000 to more than 3,000 mg/ℓ (Figure II-29).

Records of sediment loads are not available for the intermittent streams that drain the Kaiparowits Plateau impact area. The load is assumed to be large during the late summer period of cloudburst flooding. According to the type 1 comprehensive framework study of the Upper Colorado Region (Hagen, et al., 1971),

FIGURE II-31
Magnitude and Frequency of Annual Peak Discharge
in Coyote Creek



the potential sediment yield in the impact area ranges from 1 to 3 acre-feet per square mile per year in the southeast part of the area, and from about one-half to 1 acre-foot per square mile per year in the higher part of the plateau. More specific data on sediment yield are given in the preceding section of this chapter.

Because most of the usable water in intermittent streams has its source in springs and seeps, the discussion of uses in the ground water section generally applies as well to water in the intermittent streams. Any impounded, overland runoff in these streams would initially be of better quality, for most uses, than water from seeps and springs. However, the suitability of this impounded water would decrease as water evaporates and the dissolved minerals become concentrated.

Present uses of the water

Springs and seeps throughout the Kaiparowits Plateau impact area are sources of drinking water for livestock and wildlife. A seep about 6 miles northwest of Fourmile Bench supplies approximately 2,000 gallons a day for sanitary use at a coal exploratory field camp. Several springs in Cottonwood Canyon provide drinking water at roadside rest areas. Wells provide domestic water in the Glen Canyon City area. A well formerly used for washing gravel now supplies water to a fish hatchery in lower Wahweap Creek. Total withdrawal from all wells in the area is about 500 acre-feet a year, most of which is for the fish hatchery. Water consumed by livestock at seeps and springs probably totals less than 100 acre-feet a year.

Several small earth-filled dams impound ephemeral runoff for stock watering. Flows in stream channels below seeps and springs are also used for stock watering and to supply water for exploratory drilling. The total volume of water used is not known, but is presumably small.

Glen Canyon Dam is a multi-purpose storage facility which regulates river flow, thus providing for production of hydroelectric power, recreation

facilities and various other downstream uses. Withdrawal and consumptive use of water from Lake Powell for the Page and Wahweap water supplies and for construction of the Navajo power plant, totaled about 2,000 acre-feet in water year 1973, according to the Bureau of Reclamation (Letter, May 1975). The first stages of the Navajo power plant consumed about 5,900 acre-feet between June and October of 1974 -a monthly average of nearly 2,000 acre-feet. Annual average consumptive use on completion of that plant will be about 34,000 acre-feet.

The estimated volume of water (in acre-feet) used during 1974 by towns in the general vicinity of the Kaiparowits Plateau impact area are as follows: Tropic (112). Cannonville (32), and Henrieville (34). These estimates are based on populations served and on an average annual per capita daily requirement of 200 gallons, a factor used by the Utah Division of Health to estimate municipal water needs. Actual use could be somewhat less than the above estimates.

Transmission system impact area

Ground water

Ground water resources in areas which would be traversed by the transmission system will be discussed by physiographic province (Illustration II-15). However, the Transition Zone will not be discussed, since ground water conditions in this and the Basin and Range Province are similar.

Kaiparowits to Phoenix, Kaiparowits to Eldorado, Kaiparowits to Moenkopi to Mohave

The major water-bearing rocks of the Plateau Province are sedimentary rocks. The Coconino sandstone is the major aquifer (rocks that store and yield ground water) south of the Grand Canyon. North of the Grand Canyon, major aquifers, in addition to the Coconino sandstone, include the Navajo sandstone, Kayenta formation, and Wingate sandstone. Water in these rocks ranges from near surface to approximately 1,500 feet deep. These aquifers are recharged by rain and snow in higher elevations where they are exposed or near the surface. The aquifers are drained by springs in canyons tributary to the Grand Canyon.

Alluvium and volcanic rock in the Plateau Province occasionally store ground water from less than 10 to several hundred feet below the surface. Recharge of these aquifers occurs by direct infiltration of rain or snow melt, especially along contacts between the aquifer and underlying rock.

Wells in the Plateau Province yield from a few gallons to several hundred gallons per minute. Aquifers in alluvium and volcanic rock usually provide larger yields than sedimentary rock. However, these reservoirs are usually small and would not last long under sustained pumping. Dry wells are common in all parts of the Plateau Province.

Ground water in the Plateau Province ranges from fresh to moderately saline, and is normally very hard. According to water quality standards much of the ground water in this Province is not suitable for domestic use, although most is suitable for livestock and wildlife. Suitability for industrial use is variable, depending on specific requirements.

Most of the alluvium-filled valleys in the Basin and Range Province act as ground water basins. Water in these basins varies from less than 50 feet below the surface to a depth of 1,000 feet or more. Near-surface ground water is usually found in valleys near ephemeral or perennial streams where the level of the water table and recharge of the aquifer are controlled by the stream. In valleys without streams, rain and snow melt infiltrate alluvium along valley margins and recharge ground water reservoirs. Natural discharge of these reservoirs is usually in the direction of surface drainage. Wells in the Basin and Range Province yield from 20 to about 1,500 gallons a minute; however, dry wells are not uncommon in the area.

Ground water quality in the Basin and Range Province is quite variable. The water varies from fresh to moderately saline, although some waters may be very saline. The water varies from soft to very hard. The fluoride content of Basin and Range ground water frequently exceeds standards recommended by the U.S. Public

Health Service (0.5 to 1.5 mg/ℓ, depending on average air temperatures). Most of the ground water in the Basin and Range Province is suitable for the same type of uses as ground water in the Plateau Province.

Mohave to Serrano

The previous discussion of ground water conditions in the Basin and Range Province generally applies to those parts of the Basin and Range Province which would be crossed by the Mohave to Serrano segment of the proposed transmission line.

The Salton Trough is filled to great depth by unconsolidated alluvium which serves as an important aquifer. Water depth ranges from near surface to 650 feet. The alluvium is relatively permeable, and properly constructed wells have yielded as much as 4,000 gallons per minute. Most of the water varies from fresh to slightly saline, but in some instances the water is briny.

The proposed Mohave to Serrano segment would cross three major ground water basins in the Peninsular Ranges Province. They are San Jacinto Valley, Elsinore Valley, and the Orange County Coastal Plain. These basins are filled with relatively permeable alluvium in which water occurs from near surface to about 400 feet. Wells yield from 100 to 1,000 gallons per minute. Water from these basins is usually fresh to slightly saline, but is sometimes briny in coastal areas.

Most ground water along the proposed Mohave to Serrano route is probably suitable for domestic use and most agricultural uses. Suitability for industrial use will depend on the needs of a particular industry.

Northern Kaiparowits to Mohave preferred alternate, Arizona Strip preferred alternate

Previous descriptions of ground water along the proposed Kaiparowits to Phoenix, Kaiparowits to Eldorado, and Kaiparowits to Moenkopi to Mohave routes apply to the alternate routes.

Although information concerning ground water stored in individual basins is sketchy, amounts have been estimated on a regional basis. Following are estimates of ground water in storage in areas crossed by the proposed transmission system.

Region	Acre-feet
Northern, central, and western Arizona; southwest Utah	473 million
Southern Nevada	11 million
Southern California	250 million

(California Region State-Federal Interagency Group, App. V, 1971; Lower Colorado Region State-Federal Interagency Group, App. V, 1971; and Upper Colorado Region State-Federal Interagency Group, App. V, 1971)

Surface water

Kaiparowits to Phoenix, Kaiparowits to Eldorado, Kaiparowits to Moenkopi to Mohave

Although information concerning locations of springs along these segments of the proposed transmission system is sketchy, some estimates can be made. For instance, springs are more common in mountain areas or areas of rugged topography than in broad, flat areas of the Plateau Province and in valleys of the Basin and Range Province. Information is not available on the rate of discharge or water quality of springs in either province. However, water quality is probably similar to that of ground water in the same area.

Ephemeral streams and dry washes that cross the Plateau Province and Basin and Range Province carry water seasonally and during periods of heavy or frequent rain. Small washes run only during and shortly after periods of heavy rain; however, these washes join a trunk wash which may flow for several days. Ephemeral streams usually carry water during the summer and winter rainy seasons. The quality of the water cannot be described for lack of information.

Springs and intermittent streams are suitable only for a narrow range of uses since they usually are not dependable as year-round sources of water. Both are most suitable as sources of water for livestock and wildlife.

Perennial streams crossed by the proposed Kaiparowits to Phoenix segment are the Colorado River just below Glen Canyon Dam; the Little Colorado River near Cameron, Arizona; and the Verde River near Drake, Arizona. The average annual flow of each of these streams is listed below.

Stream	Annual Flow - 1965 (acre-feet)	Gauging Station
Colorado River	11,640,000	Lees Ferry
Little Colorado River at its Mouth	292,000	Confluence with Colorado River
Verde River	162,900	Near Clarkdale, Arizona

(U.S. Geological Survey Water Resources Data for Arizona, 1969)

The proposed Kaiparowits to Eldorado segment crosses several perennial streams, including the Paria River at East Clark Bench; the Kanab Creek 10 miles south of Fredonia, Arizona; the Virgin River about 10 miles southwest of St. George, Utah; the Muddy River near Glendale, Nevada; and the Las Vegas Wash about 10 miles northeast of Henderson, Nevada. The average annual flow of these streams is listed below.

Stream	Annual Flow (acre-feet)	Gauging Station Location
Paria River	21,790	Lees Ferry, Arizona
Kanab Creek	3,310	Fredonia, Arizona
Virgin River	71,193	Hurricane, Utah
Virgin River	162,000	Littlefield, Arizona
Las Vegas Wash	18,890	Near Henderson, Nevada
Muddy River	33,600	Glendale, Nevada

(U.S. Geological Survey Water Resources Data for Arizona, 1969; U.S. Geological Survey Water Resources Data for Nevada, 1972)

The Kaiparowits to Moenkopi to Mohave segment crosses the Colorado River near Glen Canyon Dam and Bullhead City, and crosses the Little Colorado River near Cameron, Arizona. The crossings at Cameron and Glen Canyon were described earlier. According to the Bureau of Reclamation (personal communication, Schumacher, 1975), the river carries about 8.5 million acre-feet of water per year below Davis Dam which is near Bullhead City. Flow fluctuates from about 2,000 to 21,000 cubic feet per second, with heaviest flows from March 1 to September 30, the annual water contract period.

Available water quality data for the above streams are tabulated below.

Stream and Location	Total Dissolved Solids (mg/ℓ)	Hardness	Suspended Sediment (millions of tons/year)
Little Colorado River near Cameron, Arizona	1,500	-	10
Paria River at Lees Ferry	109	-	6.9
Kanab Creek near Fredonia, Arizona	[a]1,600	-	.6
Virgin River near Littlefield, Arizona	[a]1,750	Very Hard	1.3
Las Vegas Wash near Henderson, Nevada	[a]1,900	Very Hard	-
Colorado River near Bullhead City, Arizona	700	Very Hard	[b]Negligible

[a]These figures are approximate, representing calculations using the average specific conductances of the water. Chemical analyses are not available.

[b]Personal communication, Schumacher, Bureau of Reclamation, 1975.

Source: U.S. Geological Survey, Water Resources Data for Arizona, 1969; U.S. Geological Survey Water Resources Data for Nevada, 1972.

Mohave to Serrano

Previous descriptions of ephemeral streams for the Basin and Range Province apply to all parts of the proposed Mohave to Serrano route. The previous discussion of springs also applies to the proposed Mohave to Serrano route.

The proposed Mohave to Serrano route crosses the White Water River near the Devers substation. This river, the principal perennial stream in the Salton Trough, flows southwest to the Salton Sea. Only the upstream portions of the river are perennial. For the period 1931 to 1960, the average annual flow of the White Water River was 12,240 acre-feet measured at White Water, California. (U.S. Geological Survey Water Resources Data for California, 1967, 1972). Specific information concerning water quality of the White Water River is not available. Consequently, limitations on potential use are unknown.

Most perennial streams in the Peninsular Ranges Province drain west to the Pacific Ocean, although some drain to enclosed basins. The San Jacinto River is the only major stream in the Peninsular Ranges Province crossed by the proposed Mohave to Serrano route. The stream drains from the San Jacinto Mountains through San Jacinto and Temecula Valleys to Elsinore Lake. The average annual flow of the river is 13,040 acre-feet (U.S. Geological Survey Water Resources Data for California, 1967, 1972). In addition, there are two reservoirs on the Jacinto River - Lake Hemet Reservoir and Railroad Canyon Reservoir. The combined capacity of the two reservoirs with a nearby reservoir is 80,000 acre-feet (California Regional State-Federal Interagency Group, 1971). Since information on water quality in the San Jacinto River is not available, limitations on potential uses are unknown.

Northern Kaiparowits to Mohave preferred alternate,
Arizona Strip preferred alternate

Previous descriptions of surface waters along the proposed Kaiparowits to Phoenix, Kaiparowits to Eldorado, and Kaiparowits to Moenkopi to Mohave routes apply to the two proposed alternates route.

Present use of water resources

In order of importance, the major uses of water in areas crossed by the proposed transmission system and preferred alternates are agricultural, domestic and industrial. Although ground water has been the major source supplying these needs, increasing demands have resulted in greater dependence on perennial streams. Major uses of ground water and water from perennial streams are listed in Figure II-3

Limestone quarry impact area

Ground water

Most ground water in the proposed limestone quarry area occurs in the underlying carbonate rocks. The water seeps into the rocks in the higher plateaus to the west and flows generally eastward beneath the proposed quarry site toward Johns Valley.

Some ground water apparently also occurs in the alluvium of the unnamed draw that trends southeastward between the proposed quarry areas as evidenced by a luxuriant growth of rabbitbrush (a plant associated with ground water) along this draw.

Depth of the water table in this area is unknown. It is probably shallower than 50 feet along the unnamed draw (where the rabbitbrush grows). However, the depth probably exceeds 50 feet along the higher slopes where the limestone would be quarried. This assumption is based on reports that no water was encountered in exploration core holes which exceeded 50 feet.

Most of the ground water passes beneath the proposed quarry site and discharges naturally (mostly by evapotranspiration) in Johns Valley to the east. However, some of the water discharges through seeps and springs by evapotranspiration in and near the quarry area (Illustration II-21). The largest spring is Tom Best Spring, which had a measured discharge rate of 20 gallons per minute on August 10, 1972. The spring discharges from fractured limestone less than a mile

FIGURE II-32

Regional Water Use in 1965 in Thousands of Acre-Feet

	Agriculture	Industrial	Domestic	Other	Total
Northern, central and western Arizona; Southwestern Utah; and southern Nevada	1,480	8	102	41	1,631
Southern California	3,490	315	1,411	--	5,216

Note: The above areas are portions of subregions as defined in the three comprehensive framework studies. Consequently, the above figures represent adjusted totals.

(California Regional State-Federal Interagency Group, App. X, XI 1971, Lower Colorado Region State-Federal Interagency Group, App. X & XI, 1971; Upper Colorado Region State-Federal Interagency Group, App. X & XI, 1971).

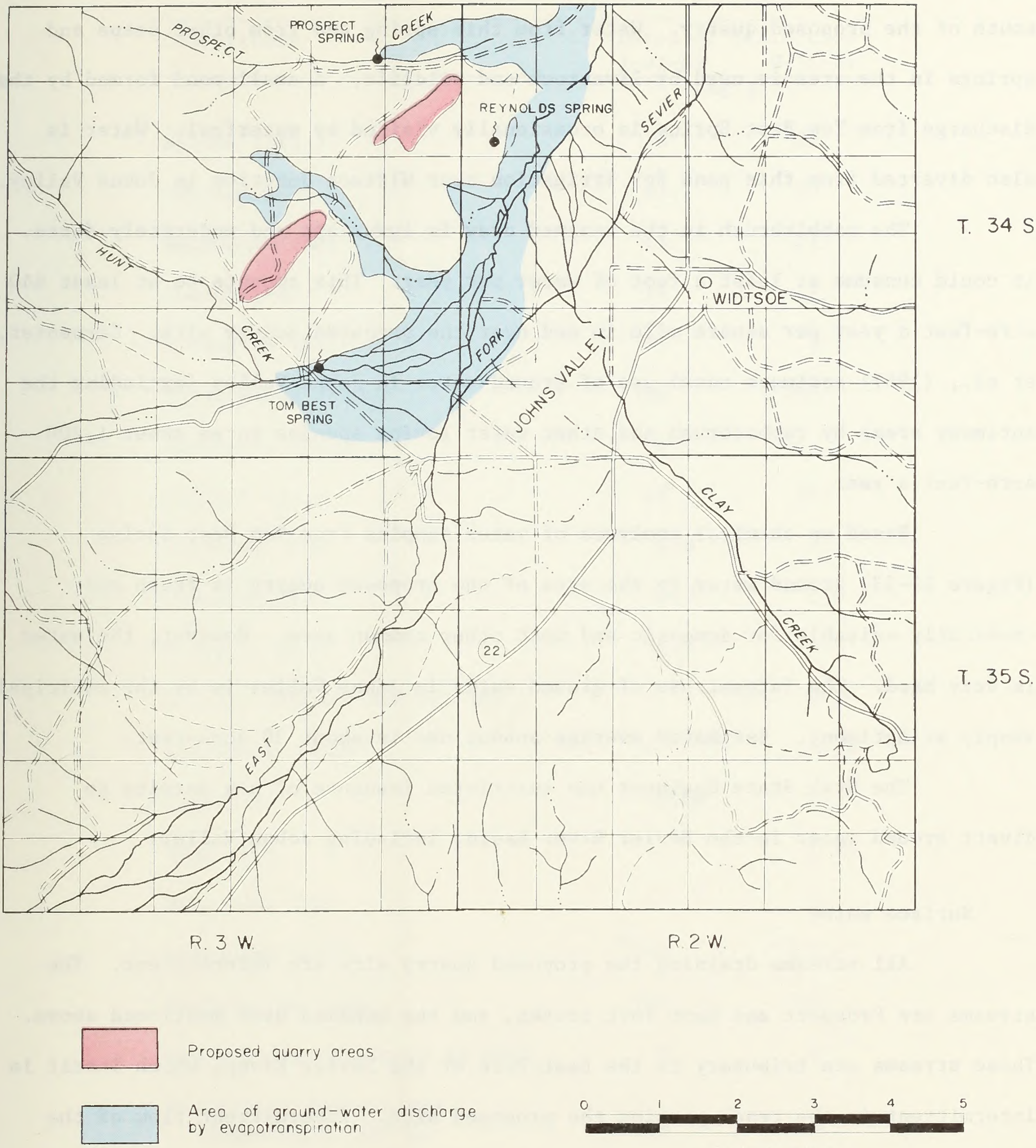


ILLUSTRATION II-21

Location of Springs and Areas of Ground Water Discharge by Evapotranspiration at Proposed Limestone Quarry

south of the proposed quarry. Water from this spring and from other seeps and springs in the area is used by livestock and wildlife. A small pond formed by the discharge from Tom Best Spring is occasionally visited by waterfowl. Water is also diverted from this pond for irrigation near Widtsoe Junction in Johns Valley.

The rabbitbrush in the unnamed draw is luxuriant and moderately dense. It could consume at least a foot of water per year. This amounts to at least 640 acre-feet a year per square mile in and near the proposed quarry site. Carpenter, et al., (1967) estimate total use of ground water in Johns Valley (excluding the Antimony area) by rabbitbrush and other water loving species to be about 1,200 acre-feet a year.

Based on chemical analyses of water samples from Tom Best Spring (Figure II-33) ground water in the area of the proposed quarry is fresh and chemically suitable for domestic and most other common uses. However, the water is very hard. The largest use of ground water in Johns Valley is by the municipal supply at Antimony. Estimated average annual use is about 30 acre-feet.

The Utah State Engineer has restricted issuance of new permits to divert ground water in the Sevier River Basin, including Johns Valley.

Surface water

All streams draining the proposed quarry site are intermittent. The streams are Prospect and East Fork creeks, and the unnamed draw mentioned above. These streams are tributary to the East Fork of the Sevier River, which itself is intermittent in the reach passing the proposed site. Intermittent flow of the streams is generally less than a cubic foot per second. However, the flow rate may exceed 100 cubic feet per second during cloudburst flooding. According to water-yield maps for Utah (Bagley, et al., 1964), mean annual runoff is just under 1 inch. Assuming it to be 0.8 inch, mean annual runoff from the 240-acre area to be disturbed by the proposed project is on the order of 16 acre-feet. Any runoff

FIGURE II-33

Chemical Analysis of Water from Tom Best Spring

Constituent	Dates of Collection 7-31-62	9-25-74
	(mg/ℓ)	
Silica (SiO_2)	30	27
Calcium (Ca)	53	50
Magnesium (Mg)	14	21
Sodium (Na)	[a]18	17
Potassium (K)	-	2.1
Bicarbonate (HCO_3)	246	269
Carbonate (CO_3)	0	-
Sulfate (SO_4)	17	11
Chloride (Cℓ)	6.0	7.7
Fluoride (F)	0.2	0.3
Nitrate (NO_3)	0.9	-
Nitrite (NO_2) + Nitrate (NO_3)	-	0.37
Phosphate (PO_4)	-	0.18
Boron (B)	0.04	0.1
Iron (Fe)	-	0.02
Manganese (Mn)	-	0
Dissolved Solid	[b]246	[b]271
Hardness as $CaCO_3$	191	210
Noncarbonate Hardness as $CaCO_3$	0	0
Electrical Conductance (mmho/cm at 25° C)	408	445
Sodium Absorption Ratio	0.6	0.5
pH	7.8	-

[a]Sodium plus potassium computed and reported as sodium.

[b]Calculated.

(Analysis by U.S. Geological Survey)

from this area reaching the East Fork of the Sevier River may eventually be used for irrigation in downstream areas. (See also the soils section of this chapter.)

According to Hahl and Mundorff (1968) surface water in the area of the proposed site is fresh, with a total dissolved-solids concentration of less than 500 milligrams per liter. Because these streams drain carbonate rocks and are partly fed by ground water, the water from them is probably hard.

Sediment yield in the area ranges from 0.1 to 0.2 acre-foot per square mile according to unpublished data supplied by the Soil Conservation Service. Average annual sediment yield from the 240 acres to be disturbed, therefore, ranges from a about .04 to .08 acre-foot. According to the analysis in the soils section of this chapter, however, total sediment yield from the area may be as much as 0.13 acre-foot a year.

Water from the Sevier River is used almost entirely for irrigation. The water is regulated by a complex system of reservoirs and diversions, including transmountain diversions. The water is fully appropriated. Permits to divert additional ground water, from sources that can be shown to drain to streams in the system, most likely would not be issued.

Vegetation

Kaiparowits Plateau impact area

Extensive inventory of the vegetation communities and individual species representing the major plant communities of the Kaiparowits region have been made beginning in June 1971. These investigations include detailed studies of each plant community, plant species lists, composition, frequency, phenological observations, productivity, and vegetation mapping employing random, fix transect, enclosure, and exclosure sampling techniques. Soils analysis included general soil description, soil moisture measurement, pentrometer data, infiltration studies, soil temperature, phenology data, and chemical analysis. Associated climatological conditions affecting vegetation such as wind speed and direction, temperature, humidity, insolation, soil temperature, evaporation, and precipitation were also measured. These studies were performed by a team of scientists from Brigham Young University and the results appear in quarterly and annual reports (Brigham Young University Reports, 1972, 1973, 1974a) and individual papers (BYU-Navajo Kaiparowits Staff Report 1974 b,c,d). A 4-year summary report is presently being prepared (Brigham Young University 1975). Individual papers from the report will be available in the Great Basin Naturalist (Wood 1975).

The plateau is unique ecologically because there is a blending of both cold desert and warm desert species.

Sparse rainfall combined with warm summer temperatures and high evaporation makes the region a relatively difficult environment for plant growth and survival. However, numerous plants have adapted, and species diversity is high. (Brigham Young University, 1973)

The major vegetation types in the impact area are pinyon-juniper woodland, mixed desert shrub, salt desert shrub, desert grassland, and sagebrush. The vegetation types, their description and distribution percentage in the area are presented in Appendix II-8.

In areas associated with springs and seeps, the appearance of the vegetation makes an abrupt change. Cottonwood trees grow near the heads of such canyons as Nipple Creek and Tibbet Canyon. Rushes, bullrushes, copperweed and a variety of grasses grow along perennially moist areas such as Wahweap and Warm creeks. Rabbitbrush, skunkbush, tamarisk, and Apache plume are the dominant vegetation in these canyon bottoms.

The ultimate form which a plant community can assume is a relatively stable condition referred to as "climax". The study area is unique in that it has areas representing a wide variety of successional stages preceding the climax condition, together with areas having all the characteristics of a climax state.

Vegetation on Fourmile Bench is predominantly pinyon-juniper woodland. When viewed aerially (Illustration II-22), pinyon-juniper trees cover approximately 62 percent of the land surface, a much larger percent than normal for this vegetation type.

According to vegetation studies performed by Brigham Young University, this pinyon-juniper woodland consists of approximately 400 trees per acre. The understory makes up only about 3 percent of the total ground cover.

Pinyon-juniper woodland on Fourmile Bench differs in its overstory canopy from most other woodlands in the region. This woodland has many of the characteristics of a climax condition. A portion of this vegetation has been in place long enough to represent the natural climax or permanent pinyon-juniper woodland. This vegetation represents a source of potentially unique scientific information. One 1,400 year old tree has been identified. Total dominance of pinyon-juniper trees in this plant community is illustrated in the average-age and size class shown below. (Brigham Young University reports)

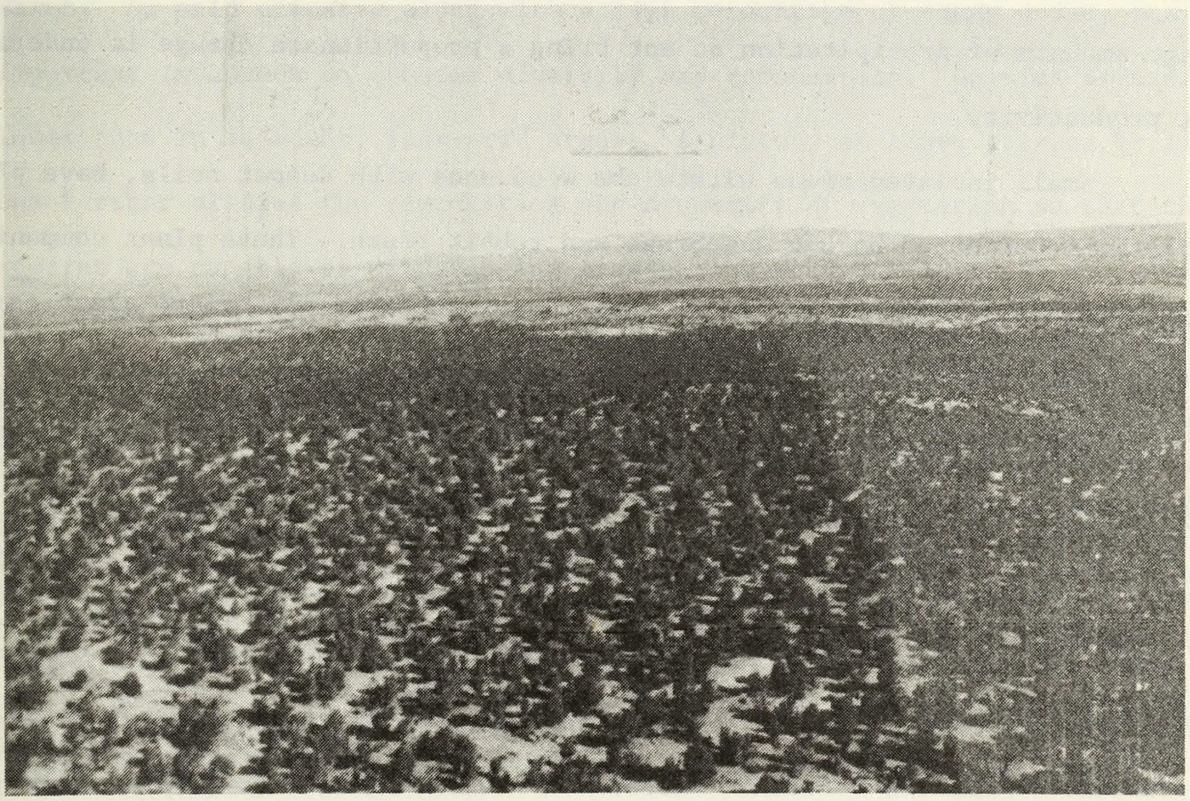


ILLUSTRATION II-22

Aerial View of Fourmile Bench

Size Class Ground level trunk diameter in inches	Average Age (years) Juniper	Pinyon
0.1 - 1.0	20	27
1.1 - 2.0	47	45
2.1 - 5.0	106	74
5.1 - 10.0	144	186
10.1 - 15.0	201	318
15.1 - 20.0	340	437
20.1 - 30.0	480	455
30+	611	507

Plant productivity in this community is low. Current annual growth of understory is estimated at less than 100 pounds an acre. The trees also grow very slowly. Herbaceous species cannot compete with the trees for moisture. Above-average amounts of precipitation do not bring a proportionate change in understory-plant productivity.

Small isolated areas within the woodlands with deeper soils, have plant associations dominated by big sagebrush and rabbit brush. These plant communities occupy about 10 percent of the area. There have not been any unique plant communities or associations identified in the area of the proposed generating station.

Most of the proposed coal mine site is covered by saltbush and mixed desert-shrub vegetation. Smaller communities of sagebrush and pinyon-juniper also occur. No unique plant communities or associations have been identified in this area. Ground cover at the proposed mine site is sparse. This area ranks only above wasteland in percent of vegetative ground cover.

In the major canyons near the mine site, moisture is more readily available. Plants are more dense and species diversity is greater than on the benches. In these canyons, vegetation is most often dominated by boxthorn with goldenhead snakeweed codominant (Brigham Young University reports).

Successional stages of plant communities here are not well defined. Plant succession is extremely slow. The area has been heavily used by livestock. The proposed mine area is presently in a succession stage preceding climax, with

no apparent upward or downward trend except in small areas, usually near water where cattle concentrate.

Vegetation productivity varies annually but is comparatively low. (Brigham Young University reports) Plant communities in the proposed mine area are drought-tolerant species. They typically lose their leaves and are dormant 6 to 9 months of the year, depending upon precipitation from October through June. Evapotranspiration is extremely high. Moisture received during the summer months does not usually become available for plant growth.

Vegetation on the proposed East Clark Bench townsite is mixed desert shrub. An arid climate, along with a high percentage of sandy soils, has an important influence on species diversity and composition. Species diversity is lower than in adjacent, less-arid areas. A history of heavy grazing by livestock has further altered the composition and diversity of vegetation so that the present species are capable of withstanding grazing and arid conditions. Successionally, the site is in a step below climax and is also in poor condition, but appears to be in a stable-to-slightly-improving trend.

Shrubs are the dominant component, amounting to nearly 50 percent of the total vegetation. The more representative species include shadscale, fourwing saltbush, blackbrush, little rabbitbrush, Brigham tea, and vanclevea. Grass species comprise 30 percent of the vegetation. Common species are Indian rice-grass, galleta, sand dropseed and three-awn. Vegetative coverage on the proposed town site is low, averaging about 14 percent, while 40 percent of the site is bare ground. There are no unique communities in the area.

At least fifteen and possibly as many as 42 species of rare, threatened or endangered species of plants occur in the Kaiparowits region proper. These plants include such species as Astragalus malacoides, Astragalus striatiflorus, Camsonia megalantha, Eriogonum scabrellum, Euphorbia nephradenia, Gilia latifolia,

Hermedium alipes, Nama retrorsum, Peteria thompsonae, Phacelia constancei, Phacelia demissa, Phacelia mammillarensis, Phacelia rafaelensis, Psoralea epipsila, Viguiera soliceps and Yucca toftae (Welsh, Atwood & Reveal, in press). Nine of these species have been classified as threatened and two have been classified as endangered under the Endangered Species Act of 1973 (Public Law 93205). The two species classified as endangered are Astragulus malacoides and Phacelia mammilarensis (Smithsonian Institution 1975.)

Transmission system impact area

Introduction

Several major natural biotic communities are crossed by the proposed transmission system. These communities, with typical plant species, are listed in Appendix II-9. Illustration II-23 shows the distribution of these communities throughout the transmission system area. A description of each vegetative community is found in Appendix II-10. Part of the biotic community description and distribution was taken from "The Natural Vegetation of Arizona" by C. H. Lowe and D. B. Brown.

Distribution of types and species

Kaiparowits to Phoenix

Vegetative communities along this segment are Great Basin desert scrub, plains and desert grassland, pinyon-juniper woodland, riparian, interior chapparal, Arizona upland Sonoran desert scrub and lower Colorado Sonoran desert scrub.

From the Kaiparowits plant site, the transmission line would cross the pinyon-juniper woodland community on the Kaiparowits Plateau. The line then would cross wasteland in the areas of large canyons and at the edge of the plateau. At the base of the plateau the line would cross Great Basin desert scrub and plains and desert grasslands to the Arizona-Utah state line. The line would cross pinyon-

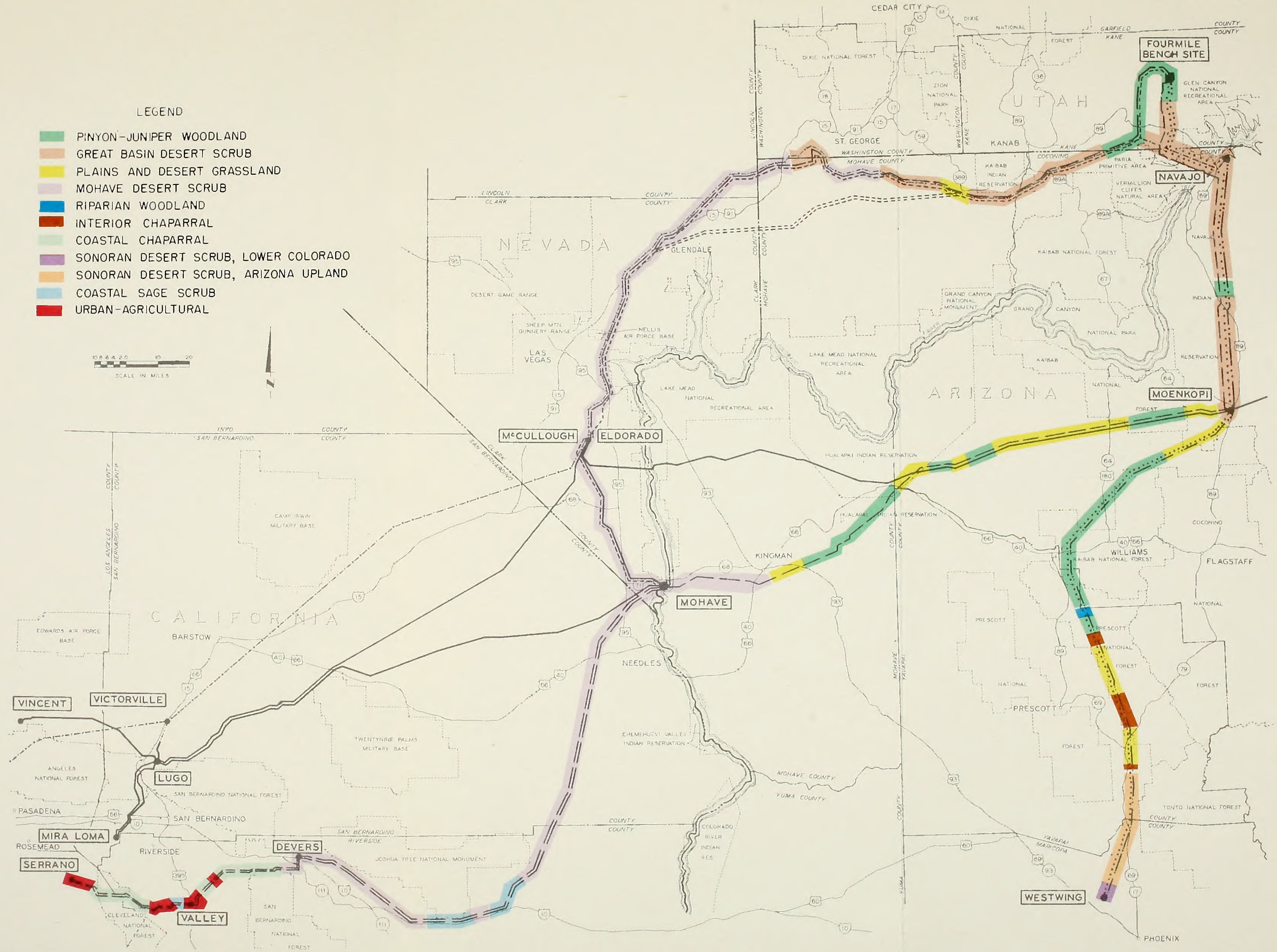


ILLUSTRATION II-23

Vegetation Communities

juniper woodland on Cedar Mountain and from there would go southeast to the Navajo Indian Reservation through the Great Basin desert scrub community. The line would cross approximately 73 miles of Great Basin desert scrub vegetation and approximately 5 miles of pinyon-juniper woodland. It would head southwest of Williams, Arizona and cross rugged, mountainous terrain of pinyon-juniper woodland in the Sawtooth area. From there it would go southwest through plains and desert grassland, and pinyon-juniper woodland. From there it would cross foothill country which is covered with chaparral vegetation on the east side of Chino Valley, then grasslands on mesas in the vicinity of Cordes Junction. It would pass through the Arizona upland Sonoran desert scrub in hilly country and finally would reach flat desert terrain through lower Colorado Sonoran desert scrub to the Westwing substation.

The route would cross numerous washes and riverbeds, including the Little Colorado, Verde, and Agua Fria rivers. True riparian deciduous woodland presently crossed by the proposed corridor includes the following:

The Agua Fria south and north of Perry Mesa (crossed by existing line).

The Agua Fria east and northeast of Bumble Bee (within the 2-mile corridor and within 2,000 feet from existing lines on the east for 5 miles).

Tank Creek on the northwest side of Perry Mesa (crossed by existing line).

Sycamore Creek (crossed by existing line east of juncture with Agua Fria).

Yarber Wash (scattered groups of riparian vegetation east of Dewey and within 2,000 feet east of existing lines for 8 miles).

Verde River and Hells Canyon (very scattered pockets at bottom of these canyons and also to the east of existing line).

Kaiparowits to Navajo

This proposed route joins the Kaiparowits to Phoenix segment near Page, Arizona where the lines would separate. The line would cross Great Basin desert scrub through 5 miles of the Navajo Indian Reservation to the Navajo power plant.

Kaiparowits to Eldorado

Along this portion of the proposed transmission system there is a blend of both cold (high desert) and warm (low desert) vegetation. From the proposed Kaiparowits plant site to the Utah-Arizona border east of Fredonia there is a series of high, rugged plateaus that rise above the valley floor. Vegetation on the tops of these plateaus is pinyon-juniper woodland, made up almost entirely of trees and shrubs.

Below the plateaus are located Great Basin desert scrub vegetative communities. Dominant shrub species vary with the local soil type. Vegetation includes nearly pure stands of shadscale in alkaline areas.

The transmission line would cross Paria River south of Cottonwood Canyon. Vegetation in the dry portion of the river is mainly tamarisk and rabbitbrush. There are also a few widely scattered cottonwood trees in the flood plain.

From Fredonia to the Hurricane Cliffs, the proposed corridor would cross vegetation consisting of a mixture of plains and desert grassland and Great Basin desert scrub. Some areas near Fredonia contain nearly pure stands of sagebrush. To the west, the vegetative aspect becomes more of a grassland-scrub community. This vast grassland-scrub association extends westward to the Hurricane Cliffs. Near the tops of these cliffs are dense stands of blackbrush.

The Hurricane Cliffs drop 1,000 feet and act as a natural barrier between the grassland-scrub association to the east and the creosote bush within the Mohave desert scrub community from the base of the cliffs to the west. Creosote bush is abundant at the base of the cliffs, but absent from the top of the cliffs. Blackbrush is present on top and at the bottom of the cliffs. Blackbrush at the bottom of the cliffs is not widespread and away from the cliffs; it occurs only on higher hills. Blackbrush in this area is in a transition zone and is found in both the Great Basin and Mohave desert scrub communities.

From the Hurricane Cliffs to near the Beaver Dam Mountains, the proposed transmission line would cross the Mohave desert scrub vegetative association. This habitat is dominated by creosote bush with gray krameria and cholla common in many places.

The proposed line would cross the Virgin River where the river actually runs underground. The area has the appearance of a dry wash with the edges heavily overgrown in many places.

The proposed transmission line would cross Beaver Dam Mountains through Cedar Wash. Vegetation found along this route reflects altitudinal changes prevalent through the mountains. Blackbrush, sagebrush and snakeweed are major constituents of the Great Basin desert scrub vegetative communities in the Beaver Dam Mountains.

The west slope of Beaver Dam Mountains is Joshua tree woodland community and has been designated as a Joshua Tree Natural Area where it occurs in Utah along the proposed line. This community continues along the proposed route to the southeast edge of Mormon Mountains. West of this area the Joshua trees are replaced by Spanish dagger in the Mohave desert scrub community. The Mohave desert scrub community continues along the proposed route to the Las Vegas Wash with few variations. The Mohave desert scrub vegetative type along this section is dominated by creosote bush.

The proposed line would cross Las Vegas Wash, which forms one of the few marsh habitats in the Mohave Desert. Water for this unique habitat is mainly effluent from the city of Las Vegas and other communities in the area. A sampling taken by the participants at the marsh area near the proposed transmission line crossing found cattail, tamarisk, arrow weed, pickle weed and salt grass are predominant components of the marsh vegetative community.

Along the remainder of the proposed route between Las Vegas and Eldorado substation a typical creosote bush-burrobush association prevails. Thornbush, gray krameria, Mormon tea and many species of cactus are common to this association.

Kaiparowits to Moenkopi to Mohave

Vegetation along this proposed route is the same as the Kaiparowits to Phoenix line described above to Moenkopi, a distance of approximately 113 miles. From Moenkopi, the proposed line would cross approximately 5 miles of vegetation in the Great Basin desert scrub and approximately 15 miles of plains and desert grassland communities in the Navajo Indian Reservation to Kaibab National Forest. Vegetation through Kaibab National Forest is pinyon-juniper woodland. Between the forest and Hualapai Indian Reservation there is a pinyon-juniper woodland community, approximately 75 percent of which is on private land and has been cleared through range improvement practices and seeded to grass.

The proposed line then would cross approximately 6 miles of grassland and 2 miles of pinyon-juniper woodland in the Hualapai Indian Reservation. It next would cross pinyon-juniper woodland and plains and desert grassland to near Kingman, Arizona. From Kingman, the line would cross Mohave desert scrub vegetation to the Mohave generating plant.

Mohave to Serrano

The proposed line would cross Mohave desert scrub vegetation from the Mohave Generating Plant to the west side of the Coxcomb Mountains and from the Cottonwood Mountains to the base of the San Jacinto Mountains. The ocotillo-palo verde-catclaw association (within the Mohave desert scrub community) would be crossed by the proposed route on the south and east side of Joshua Tree National Monument and from the Cottonwood Mountains east to near the base of the Coxcomb Mountains.

Alkali sink scrub areas within the Mohave desert scrub community are scattered along the proposed route where it would cross Danby and Hayfield dry lakes and approach Cadiz and Bristol dry lakes.

Fan palm oases are scattered along the southern slopes of the Indio Hills. These relic communities are located along seeps, fault lines or capillary fringes on mountains. These fan palms are located at Willis Palms, Hidden Palms, Pushawalla Palms and other areas in the vicinity of Indio Hills.

Coastal sage scrub is found from the base of the San Jacinto Mountains west at lower elevations along the Devers to Serrano portion of the proposed route. The proposed line would cross undisturbed areas of coastal sage scrub at the west end of Lamb Canyon and in the hills east of Alberhill, California. The San Jacinto Valley east to the boundary of Cleveland National Forest is predominantly agricultural land with small pockets of undisturbed coastal sage scrub. This vegetation is also located in a narrow strip along the proposed line at the base of the San Jacinto Mountains.

Northern Kaiparowits to Mohave preferred alternate

This route is the same as the Kaiparowits to Eldorado route for the first 269 miles. From the Eldorado substation, the proposed route would cross Mohave desert scrub vegetation to the northeast edge of the Highland Mountain range where it would cross vegetation of the Joshua tree woodland community. However, Joshua trees are not dense in this particular area. From the southeast edge of the Highland Mountain range to the Mohave substation, vegetation is of the Mohave desert scrub community.

Arizona Strip preferred alternate

Vegetation along this proposed route is the same as the above-described Kaiparowits to Eldorado route for the first 80 miles, to a point where the lines

separate near the southwest corner of Pipe Springs Indian Reservation. From there the proposed line would cross vegetation of the plains and desert grassland and Great Basin desert scrub communities to the top of Hurricane Rim.

The proposed line then would cross a plains and desert grassland community from the base of Hurricane Rim west to the south edge of Seegmuller Mountain. The proposed line then would cross a short segment of Great Basin desert scrub vegetation and enter a pinyon-juniper woodland community that has been partially chained and seeded to grass, south and west of Wolfhole Mountain. The line then would continue through pinyon-juniper woodland to the north end of Mud Mountain where it would cross a short segment of the Mohave desert scrub community. However, vegetation in this area is not typical of the Mohave desert scrub as described by Lowe and Brown in "The Natural Vegetation of Arizona". Manzanita (*Arctostaphylos pringlei*) and algerita (*Berberis fremonti*) occur in this area. This vegetation appears to be in a transition zone of the pinyon-juniper woodland community as it occurs in that community in the surrounding area. The proposed line would continue on through pinyon-juniper woodland across the Virgin Mountains. Dropping off the Virgin Mountains, the proposed line would cross the Joshua tree woodland community to near the Virgin River. From the Virgin River, across Mormon Mesa to where the proposed line would connect with Kaiparowits to Eldorado proposed line, vegetation is of the Mohave desert scrub community.

The rest of this route to the Mohave generating plant, a distance of approximately 125 miles, is the same as the Kaiparowits to Eldorado to Mohave proposed line.

Ground cover

The entire transmission system impact area, except for chaparral and coastal sage communities, is sparsely vegetated. Vegetation ground cover varies considerably by community with the chaparral and coastal sage exhibiting a relatively

high percentage of cover (60-plus percent). The Great Basin desert scrub, plains and desert grassland and generally the pinyon-juniper woodland are somewhat intermediate in ground cover. The Mohave desert scrub and Sonoran desert scrub communities often exhibit only a 2 to 20-percent ground cover.

Land containing less than 2 percent ground cover is considered barren. Land containing over 2 percent vegetation on steep, rocky areas is referred to as waste from the vegetative standpoint.

Generally, those areas that receive very little precipitation, such as areas in the vicinity of Las Vegas, have a very low percentage of ground cover. Those areas receiving a higher, more balanced supply of moisture, such as the coastal sage and chaparral area, contain a much higher percentage of ground cover.

Composition

Composition of the vegetation varies considerably, both between and within each biotic community. Dominant plant species within each vegetative community are shown in Appendix II-9. The percent of each vegetative class, such as trees, shrubs, forbs and grasses varies greatly within each vegetative community.

The proposed powerline system passes through vegetative communities as indicated in Figure II-34.

Included in the Mohave desert scrub community are small local areas of the desert wash association, alkaline sink association, and riparian vegetation association. There are also small local areas of wasteland and barren land.

Successional stages

Successional stages of plant communities within the proposed transmission system impact area vary considerably and are difficult to define. Factors other than natural environment which influence the successional stage of a community include the past grazing use as well as present management of that area.

FIGURE II-34

Vegetative Communities

Vegetative Community	Kaiparowits to Phoenix Miles	Kaiparowits to Navajo Miles	Kaiparowits to Eldorado Miles	Kaiparowits to Moenkopi to Mohave Miles	Mohave to Serrano Miles
Pinyon-juniper woodland	84	16	32	89	---
Great Basin desert scrub	97	28	82	93	---
Plains & desert grassland	51	3	16	88	---
Mohave desert scrub	--	--	113	36	190
Riparian communities, woodland	5	--	--	2	---
Chaparral, interior	17	--	--	--	---
Chaparral, coastal	--	--	--	--	45
Sonoran desert scrub lower Colorado	5	--	--	--	---
Sonoran desert scrub Arizona upland	40	--	--	--	---
Coastal sage scrub	--	--	--	--	3
Urban-agricultural	--	--	--	--	29
Joshua tree woodland	--	--	26	--	---
Total Miles	299	47	269	308	267

Productivity

Vegetative productivity within the proposed system is extremely variable. Yearly and seasonal differences are directly influenced by differing amounts of precipitation, especially in the various desert scrub communities. The reason for the differences is the amount of annual vegetation produced in some years and not in others. Pounds of vegetation produced per acre annually may vary from a low of about 100 pounds to a high of about 4,000 pounds within any of the same desert scrub communities. Productivity of the pinyon-juniper woodland is generally low, but varies considerably along the proposed routes. Generally, productivity is low in those areas receiving little moisture and greater under more moist conditions, although, in some types such as the alkali sink vegetative association, soils play an important part in productivity. This is also true of most vegetative types outside the desert scrub communities. Some communities such as chaparral vegetative types are highly productive in terms of volume of plant life, but are extremely low in production of usable forage for livestock or wildlife. In order to be productive to man, they must be cleared of vegetation and reseeded.

Relationship to soil type and moisture

The amount of precipitation, the season during which it falls, plus the ability of the soil to hold moisture, are factors in determining the type of vegetation and the productivity of a vegetative community. Along the proposed transmission system, large amounts of precipitation are received during a short period of time in the summer. Evaporation rate and amount of runoff are high, resulting in only a small amount of moisture being available to the plants. Type of vegetation which exists under these conditions is more a product of precipitation than of soils.

Alkali sink scrub vegetation of the Mohave desert scrub community is restricted to alkaline soils. With this exception, desert plant communities are

limited by moisture and not soil type. Some species do exist which are restricted to specific soil types but these are not dominant desert species and make smaller contributions to the desert ecosystem.

In areas receiving between 15 to 25 inches of rain per year, coastal sage scrub occurs almost entirely on unconsolidated soil material, such as gravel washes, loosely consolidated sediments, talus slopes, and colluvial deposits. In areas where annual precipitation is less than 15 inches, coastal sage scrub frequently occurs on residual soils. Chaparral is found at elevations above coastal sage scrub in areas with heavier soils and more moisture.

In other communities, the type of vegetation in any particular area is a product of both the soil type and precipitation pattern for that area.

Rare and endangered species

The following plants may occur in the vicinity of the proposed powerline system and are considered of such significant importance that they have been protected by Arizona state law:

All Arizona species of these families: Liliaceae (lily), Amaryllidaceae (amaryllis), Orchidaceae (orchid), Crassulaceae (orpine), Cactaceae (cactus).

All Arizona species of these genera: Aquilegia (columbine), Lobelia (lobelie), Dodecatheon (shooting star), Primula (primrose), Fouquieria (ocotillo).

The following species: Atriplex hymenelytra (desert long), Cercis occidentalis (western rosebud), Dalea spinosa (smoke tree), Holacantha emoryi (crucifixion thorn), Fremontia california (flannel bush).

The following are protected native plants that are prohibited from collection except for scientific or educational purposes under permit: Washingtonia filifera (fan palm), Lysiloma thornberi, (ornamental tree), Bursera fagaroides (elephant tree), Cereus schottii (senita or "old one"), Cereus thurberi (organ pipe cactus), and other cactus plants.

Since many of these plant species are known to occur in the vegetative types crossed by the proposed transmission line, these species may occur along the proposed route even though they have not been identified. Several species endemic to soil parent materials are found in the area of Fredonia, Arizona; they are Pediocactus sileri and Eriogonium thompsonii var. Atwoodii. An intensive vegetative survey of the total route has not been made.

A report on endangered and threatened plant species of the United States was presented to the Congress of the United States by the Smithsonian Institution. The endangered or threatened plant species in that list for the four states that are crossed by the proposed transmission lines are listed in the Appendix. Some of these plant species may occur along the proposed routes.

A list of plant species that may be endangered or threatened and may occur along the proposed transmission lines in southern Utah or northern Arizona was developed by Dr. Atwood, BLM employee, Cedar City, Utah, and is listed in Appendices II-11 and II-12.

Figure II-35 lists plants considered rare or endangered by the California Native Plant Society and which occur in the vicinity of the proposed power line system.

Unusual vegetational occurrences

Unusual vegetation is found where the proposed transmission line would cross the Las Vegas Wash. Cattail, tamarisk, arrow-weed, pickle weed, and salt grass are important components of this area. Should the Las Vegas effluent be treated or recycled by some other method which would stop the flow, this vegetation would revert to more typical desert vegetation.

Willow Hole, a small alkaline wash at the north end of Indio Hills, is densely packed with arrow-weed and salt bush. Fifteen to 20 fan palms are scattered along the wash. The oases scattered along the south end of Indio Hills is unusual

FIGURE II-35

California Native Plants - Rare and Endangered

Vegetative Community	Common Name	Plant Species	Location
Mohave desert scrub	fan palm	Washingtonia filifera	South of Indio Hills
Chaparral, coastal sage scrub	brodiaea	Broadiaea filifolia	Near Perris, Calif.
Coastal sage scrub Pinyon-juniper woodland	foxtail cactus	Coyphantha vivipara alversonii	Little San Bernardino to Eagle and Chuck-awalla Mtns.
Chaparral	Mohave tarweed	Hemizonia mohavensis	San Jacinto Mtns.
Mohave desert scrub Chaparral, Pinyon-juniper woodland	live-forever	Dudleya saxosa aloides	Desert Mtns. of San Bernardino Co., desert slopes of San Jacinto Mtns.
Mohave desert scrub	ditaxis	Ditaxis adenophors	Sandy flat below 500 ft., Coachella Valley
Mohave desert scrub	California ditaxis	Ditaxis californica	Sandy washes, 400 to 3,000 ft., Santa Rosa to Eagle Mtns.
Mohave desert scrub Jushua tree woodland	linanthus	Linanthus arenocola	Mohave desert, Needles California
Mohave desert scrub	chorizanthe	Chorizanthe leptoceras	Sandy places, Elsinore, Calif. area
Mohave desert scrub	desert ayenia	Ayenia compacta	Dry rocky canyons below 1,500 ft., edge Colorado desert to Eagle Mtns.

in that the vegetation consists of fan palms, cat claw mesquite, cattail and other plants associated with standing water. These fan palm oases are not actually in the proposed line right-of-way, but very near to it.

Communication sites

These sites would generally be located on high points or mountain peaks and have shallow or rocky soils. The environment for vegetation is harsh, resulting in a low percentage ground cover, poor plant composition and overall low vegetative production in these areas.

Limestone quarry impact area

Vegetation reflects geology in this area. Trees grow on the limestone outcrops. Alluvial and colluvial soils along margins of the limestone hills are occupied by low shrubs, grasses, and forbs. Scientific names of the vegetation species in the following discussion can be found in Appendix II-8. Principal tree vegetation is dominated by two-needle pinyon pine and by Utah juniper (Figure II-36 and Illustration II-24). Rocky Mountain juniper occurs, especially in association with ponderosa pine, as scattered trees or in small groves. Western bristle-cone pine occurs on outcrops at two localities near the south edge of the claim, with several mature trees in the area averaging approximately 420 years in age; however, at least 60 percent of the trees are less than 100 years old. Comparable trees at nearby Bryce Canyon National Park are in the 1,000 plus-year age class.

Open areas in the valleys are dominated by shrub-grass mixtures. Dominant shrubs are pygmae, black, and big sagebrush, with black sage being the most common. Species of blue grass, needle-and-thread grass, and blue grama are the most important of the grass flora. Smooth brome and crested wheat grass have been introduced in reseeded areas on national forest land in the vicinity. Indian ricegrass and three-awn grass are present in the shrub-grass communities.

FIGURE II-36

Dominant Species of Vegetative Communities
of the proposed Limestone Quarry Site

Vegetative Community	Class	Common Name	Scientific Name
Pinyon-juniper Woodland	Trees	Two-needle pinyon	Pinus edulis
		Utah juniper	Juniperus osteosperma
		Rocky Mountain juniper	Juniperus scopulorum
		Ponderosa pine	Pinus ponderosa
		Western bristle-cone	Pinus aristita
	Scrubs	Big sagebrush	Artemisia tridentata ssp. tridentata
		Black sagebrush	Artemisia arbuscula var. nova
	Grasses	Bluegrasses	Poa spp.
		Needle and thread	Stipa spp.
		Blue grama	Bouteloua gracilis
		Smooth brome	Bromus inermis
		Crested wheatgrass	Agropyron cristatum
		Indian ricegrass	Oryzopsis hymenoides
		Three-awn	Aristida spp.

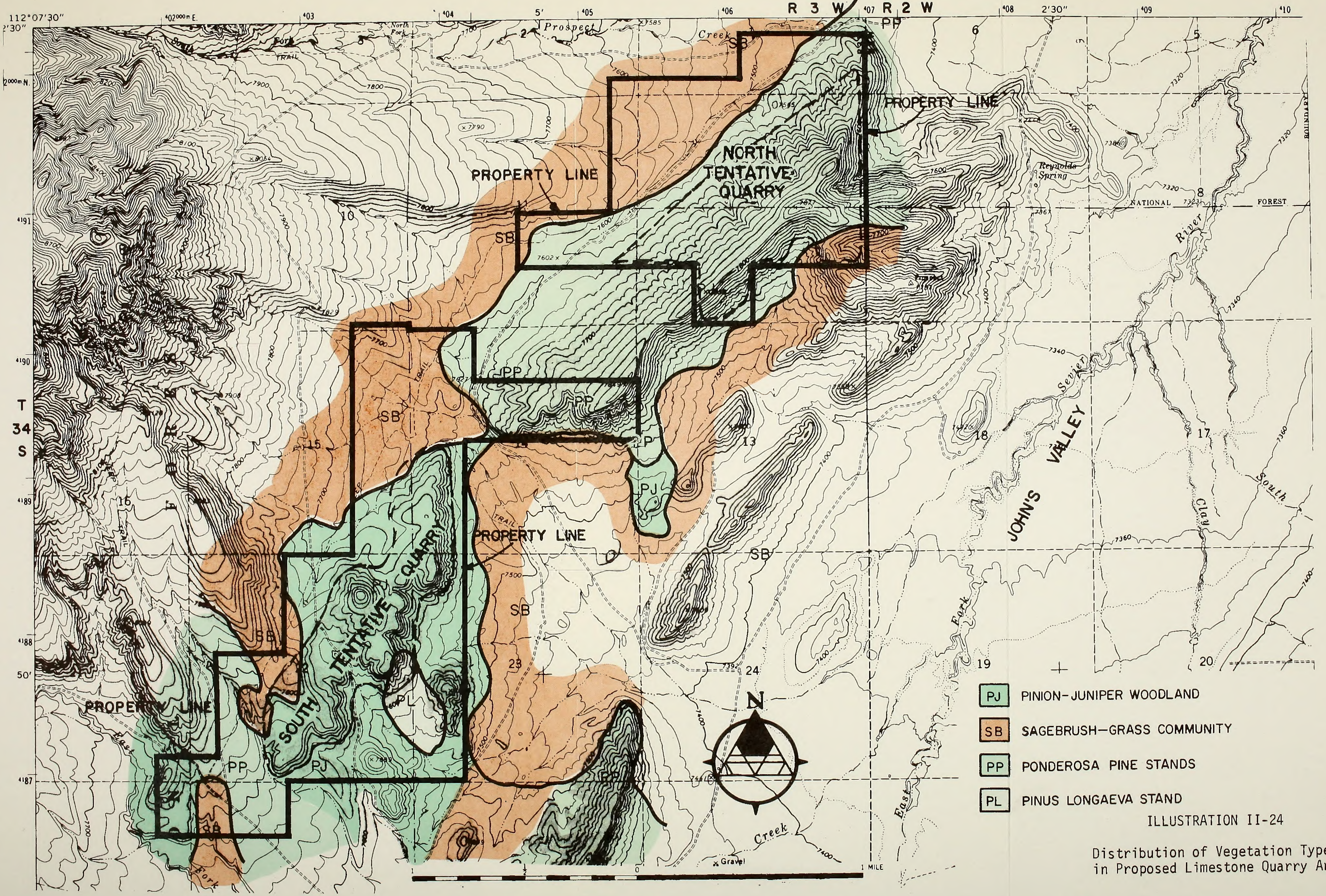


ILLUSTRATION II-24

Distribution of Vegetation Types in Proposed Limestone Quarry Area

Several unique plant species occur in this area, such as western bristlecone (Pinus longaeva), dwarf sagebrush (Artemisia pygmaea), Panguitch buckwheat (Eriogonum panguicense), Jones oxytrope (Oxytropis jonesii), and low daisy (Townsendia minima). Panguitch buckwheat is classified as a threatened species under the Endangered Species Act of 1973 (Smithsonian Institution 1975).

Wildlife

Kaiparowits Plateau impact area

Wildlife in the impact area are notable more for diversity of species than for dense populations of any one kind of animal.

Big game

Mule deer

Mule deer is the principal big game animal of the area. The herd is of modest size, compared with the major deer herds of Utah. A 1964 big game range inventory report by the Utah Division of Wildlife Resources classifies the pinyon-juniper habitat of Fourmile Bench, and adjacent benches of similar elevation, as winter range for deer which spend the rest of the year at higher elevations around Canaan Peak to the north. More recent observations by a team from Brigham Young University reveal a small population that occupies the bench tops in the spring but spends winter and summer in canyons and breaks below Fourmile Bench. The impact area is in a climate zone where summer and winter ranges are not always clearly defined.

Practically all suitable habitat is already used by deer and there is little potential for expansion of the species' range. However, population and range surveys by the state agency suggest that the existing range could support more animals. The state's herd unit No. 60B-Kaiparowits includes the deer inhabiting the impact area. This unit is open to hunting during the regular statewide deer season. An average annual kill of 65 deer by 111 hunters occurred during the period 1966-1972. In the 3-year period 1959-1961 when deer were more plentiful, the average annual kill was approximately 300 deer by 433 hunters.

Bighorn sheep

Much of Utah, including the Kaiparowits area, was once inhabited by bighorn sheep. During early years of white settlement, indiscriminate killing,

competition from domestic livestock, and disease and parasites introduced by livestock reduced the population to a few remnants in the most remote areas of southeastern Utah. In more recent years, the population has gradually increased in response to better protection and improved practices in livestock grazing. Most of the increase is reflected in the Red Canyon region, which is separated from the Kaiparowits area by Lake Powell and the Colorado River. A few bighorn sightings have been reported in peripheral portions of the impact area in recent years, but the spread of bighorn into the Kaiparowits area has been hampered by Lake Powell and the Colorado River.

An intensive study in Red Canyon (Irvine, 1969) indicated types of habitat suitable for bighorn sheep. Similar type habitats can be found in the Kaiparowits Plateau impact area. According to the study, bighorn sheep tend to avoid large expanses of dense pinyon-juniper woodlands, preferring rocky canyons and talus slopes. Plant species of the Kaiparowits area known to be significant food items include blackbrush, rabbitbrush, Indian ricegrass, galleta grass, Russian thistle, and cheatgrass. There is normally no regular migration between summer and winter range. However, local movements occur seasonally in response to changing availability of water and food.

During hot, dry periods, range usable by a bighorn is limited by the availability of water. In the Red Canyon study, 82 percent of the sheep were sighted within a mile of known free water. Human activity or the presence of domestic livestock can cause bighorns to abandon otherwise suitable range (Irvine, 1969).

Pronghorn antelope

Antelope were eliminated many years ago by uncontrolled hunting and competition from introduced livestock. The animal was reintroduced recently by the state on East Clark Bench in the southwestern portion of the impact area.

Releases of 22 and 105 animals were made in 1970 and 1971, respectively. The population, which presently centers around East Clark Bench is unknown.

If antelope numbers increase and a viable herd becomes firmly established the population would likely remain, barring major disturbance, centered around East Clark Bench because of habitat requirements of the species. Antelope prefer open rangeland and gentle topography. Extremely rugged terrain makes much of the Kaiparowits area unsuitable. The major benches are comparatively level on top, but are in many cases covered with large expanses of pinyon-juniper woodland which makes them unsuitable. A few antelope are known to have travelled north through Cottonwood Canyon to the open grasslands near the town of Cannonville. However, the primary antelope habitat extends roughly from Wahweap Creek on the east to the Paria River on the west, and from a few miles north of U.S. Highway 89 south to the Arizona boundary and a few miles beyond, in places. Poaching is thought to be an important factor in holding down the population.

Mountain lion

The mountain lion, historically thought of and hunted as a predator, has recently received some legal protection. It has been classed as a game animal and may be hunted for sport only a portion of the year, with a bag limit of one. Individual lions preying on livestock may still be killed under permit any time of the year. Numbers are believed to be increasing in response to protection. The range of the mountain lion coincides approximately with that of the mule deer; the largest population is located on Fiftymile Mountain. The inaccessibility of this high bench provides considerable protection from hunters. Also, in addition to small mammals, deer are found year round on Fiftymile Mountain, thus providing additional food for the animals.

Small game birds and mammals

Mourning doves are common summer residents throughout most of the Kaiparowits area, occupying the grasslands, desert shrub, pinyon-juniper woodlands, and stream-side bottom lands. Nesting occurs in pinyon-juniper woodland, cottonwood trees along the streams, and occasionally on the ground.

The chukar, an exotic game bird now widely distributed in the arid West, has been introduced in the area. The population has thus far remained small, limited to an area along the Paria River. Primary habitat of the chukar is grassland and desert shrub vegetation along canyon floors and adjacent steep rocky slopes. Water is crucial to survival, and chukars are normally found within a mile of a watering place.

Small populations of Gambel's quail occur in Kane and Garfield counties but very few are found within the Kaiparowits impact area. The range of this species, in this area, is limited to the vicinity of the Paria River.

Forested mountains immediately to the north of the Kaiparowits area provide summer breeding habitat for the band-tailed pigeon. This bird is an occasional visitor to the pinyon-juniper woodlands of the higher benches, in northern portions of the impact area.

The desert cottontail is common throughout much of the plateau. Moderate populations occur on the principal benches and along the flood plains of perennial streams, particularly Cottonwood Creek and Paria River.

The deep waters of Lake Powell bounded by sheer rock cliffs and desert vegetation do not provide very productive habitat for waterfowl. However, numerous species do use the reservoir as a resting place during spring and fall migration. A few ducks remain all winter. Most habitat at Lake Powell is in coves where tributaries enter the reservoir. In these areas, shallower water provides some aquatic vegetation and animal life at depths accessible to waterfowl. Major tributaries in the impact area are Wahweap, Warm, and Last Chance creeks.

Major habitat requirements for principal game animals of the Kaiparowits Plateau impact area are summarized in Figure II-37.

Nongame species, including birds of prey

The many species of small nongame mammals, birds, reptiles, amphibians and terrestrial invertebrates have received far less study in the past than the major game species. Consequently, their numbers, distribution, and habitat requirements are not well-known. However, the impact area very likely contains a number of invertebrates and possibly some reptiles and amphibians that have not yet been discovered.

Birds of prey

Rocky cliffs and ledges of the many steep-walled canyons in the impact area provide excellent nesting sites. This, combined with diverse populations of small mammals, seclusion and relatively little human disturbance, makes much of the Kaiparowits area productive habitat for a number of birds of prey (raptors). The golden eagle is common year round. The permanent nesting population is joined in the winter by migrants from farther north. The bald eagle occurs as an uncommon winter resident. (The bald eagle of the Kaiparowits Plateau impact area is not the southern sub-species which is on the Department of Interiors list of endangered fauna.)

Other birds of prey common to the area include the ferruginous hawk, rough-legged hawk, red-tailed hawk, prairie falcon, sparrow hawk and several species of owl. The peregrine falcon, an endangered species, passes through the area as a summer transient. A complete list of birds of prey and vultures is presented in Appendix II-13.

Resident populations of eagles, hawks, owls, and vultures are relatively stable at present and have not suffered the degree of loss common to many other areas. Some of the major causes of mortality elsewhere are largely absent in the

FIGURE II-37

Major Habitat Requirements of Game Animals in Impact Area

	Mule Deer	Bighorn	Antelope	Mountain Lion	Cotton-tail	Mourning Dove	Chukar	Gambel's Quail	Water-fowl
Major Habitat Type									
Desert grassland		X	X		X	X	X	X	
Desert shrub	X	X	X		X	X	X	X	
Pinyon-juniper woods	X			X	X	X			
Streamside bottomlands	X				X	X	X	X	
Open water or marsh									X
Important Habitat Components									
Proximity of free water	2	1	2	1	3	2	1	1	
Close association of food and cover	2	2			2	2	1	1	
Freedom from human disturbance	2	1	1	1	3	3	2	2	
Succulent vegetation	2	2			1		3	3	
Gentle topography			1						
Rugged topography		1		2			1		
Open expanse of low vegetation			1						
Abundant prey animals				1					
Migration routes	1	1	1						

1 = highly important
2 = moderately important
3 = slightly important

Kaiparowits area. Loss of reproductive capacity from pesticide or toxin accumulation in the food chain is not a major problem, due to the limited agriculture and urbanization.

Nongame birds, other than birds of prey

Although large numbers of birds are seldom seen at any one time or place, the total number of species occurring in a year throughout the Kaiparowits area is surprisingly large. About 200 species are found in the area at some time during the year in addition to the game birds, raptors, and owls.

A complete listing of birds in the general Kaiparowits area, including the waters of Lake Powell, is found in Appendix II-14. Appendix II-15 lists birds observed in the immediate vicinity of Fourmile Bench. This site list is likely to be incomplete as the observation periods were comparatively short.

The many species of nongame birds have diverse requirements for feeding, nesting, and shelter. Consequently, nearly all of the Kaiparowits area is used by some birds at least seasonally.

Nongame mammals

Coyotes, bobcats, gray foxes, and badgers are the principal nongame carnivores of the area. (Mountain lions are discussed under game animals.) Populations are relatively stable. However, a recently increased market price for predator pelts, especially for that of the bobcat, has resulted in an increase in hunting and trapping pressure on most of these species. Yet some portions of the impact area are so remote that predator populations have not been significantly affected.

Most of the predator mammals are distributed throughout the area except in the most barren terrain. The predators concentrate near major population areas of the rodents and rabbits, which are their main sources of food. These areas are primarily the desert shrub, pinyon-juniper, and grassland habitat of the major

benches (including Fourmile), and the narrow belts of riparian canyon-bottom habitat.

All the predator mammals are permanent residents of the Kaiparowits area and seasonal movement is limited. Snow is seldom deep enough on the benches to force migration to lower elevations.

Most of the predators adapt readily to a variety of habitat conditions, and it is difficult to identify a single type of habitat crucial to their existence.

Small mammals

The harsh, arid terrain supports a surprisingly diverse population of small mammals. Thirty-one different species, exclusive of fur animals, occur in the impact area. The small mammals present are summarized in Figure II-38.

The small mammal population is characterized by great diversity of species rather than by large numbers of individual animals. However, relatively dense concentrations of some do exist in the more favorable habitat. All small mammal populations are subject to drastic short-term fluctuations with changes in weather, food supply, predation, and disease. However, no long-term population trends, upward or downward, are known to exist.

It is not practical to relate each of the many small mammals to a specific habitat type. Some are widely distributed, occupying several major types of vegetation and terrain. However, some broad generalizations can be made concerning habitat requirements of some major groups.

Woodrats (also called packrats) live on the rocky hillsides and pinyon-juniper benches. The bushy-tailed woodrat is primarily a woodland species found on the higher benches. Some of the mammals range farther down the canyons into the desert scrub. The woodrats are vegetarians, feeding on seeds, grasses, bulbs, bark, and fungi.

Chipmunks live mainly in the pinyon-juniper woodland, and feed largely on seeds, berries, and insects.

FIGURE II-38

Small Mammals of Kaiparowits Plateau Impact Area

Genus	Common Name	Number of Species
Neotoma	Woodrat (Packrat)	5
Peromyscus	Whitefooted Mouse	5
Perognathus	Pocket Mouse	5
Reithrodontomys	Harvest Mouse	1
Onychomys	Grasshopper Mouse	1
Dipodomys	Kangaroo Rat	1
Ammospermophilos	Antelope Ground Squirrel	1
Eutamias	Chipmunk	1
Citellus	Rock Squirrel	1
Thomomys	Pocket Gopher	1
Lepus	Jackrabbit	1
Sylvilagus	Cottontail	1
Myotis	Bat	3
Pipistrellus	Bat	1
Lasionycteris	Bat	1
Eptescius	Bat	1

Ground squirrels, particularly the antelope ground squirrel, are widespread and adaptable, ranging from grassland and desert shrub areas up into the pinyon-juniper woodlands of the higher benches. The squirrels eat grasshoppers, beetles, flies, and larvae, as well as vegetable matter.

The grasshopper mouse normally prefers insects to seeds and vegetation. This mouse consumes many large insects including grasshoppers.

Whitefooted mice are probably the most common and widespread small rodents in the impact area. At least one species of this genus is represented in nearly every type of habitat.

All six species of bats in the area feed almost exclusively on insects caught in flight. Stream-side and lake-shore habitat are important sources of night flying insects. Bats find resting places mainly in the rock crevices of the many steep canyon walls. The populations are dispersed, occurring in small groups rather than as one huge colony occupying a single cave, as is sometimes the case elsewhere.

Cottontails and jackrabbits are widely distributed, occupying riparian grassland, desert shrub, and pinyon-juniper habitats, usually on the more level terrain of the bench tops and canyon floors. These species are completely vegetarian.

Small mammals of the impact area are adaptable to a broad range of conditions. It is difficult to identify single habitat elements crucial to their survival. All the small rodents are capable of going without water for long periods. Water requirements are satisfied with moisture from succulent vegetation and insects in the diet. Some species also can synthesize water from dry food through metabolic processes. Thus, water supply is not normally a crucial factor. These animals occupy essentially the same habitat year-round. Shelter and hiding places are plentiful in the rocky, rugged terrain.

Threatened and unique species

No threatened or unique species of wildlife are known to regularly inhabit the Kaiparowits Plateau impact area. The peregrine falcon is on the Department of the Interiors 1974 list of endangered fauna. Individuals of this highly mobile species probably pass through the area, but none are known to frequent the area on a regular basis. The same is true of the spotted bat, a species formerly listed as threatened.

Three endangered species of fish, the Colorado squawfish, the woundfin, and the humpback chub, inhabited the Colorado River adjacent to the Kaiparowits Plateau impact area prior to inundation by Lake Powell. However, it is doubtful if significant numbers of these species remain in the lower portion of the reservoir where the original swift, muddy river habitat has been completely altered. Some small streams in the surrounding area of secondary influence may still contain a pure strain of the Colorado River cutthroat trout. This is the race of cutthroat trout originally native to the region but now largely eliminated by hydridization caused by the introduction of trout and by habitat alteration. The Colorado cutthroat is not on the U.S. List of Endangered Fauna but has been considered for inclusion.

Some animals, though not unique as a species, form a unique or unusual segment of the environment within the area of secondary influence. The bison herd on the Henry Mountains to the northeast of the Kaiparowits Plateau impact area is near unique. It is one of the few completely free-roaming wild herds of bison in the nation. The antelope population of East Clark Bench and vicinity might be considered somewhat unique, locally, since this is a small isolated herd widely separated from other significant antelope populations. Wild turkeys are found in only a few, small areas of Utah, one of which is the south slope of Boulder Mountain within the area of secondary influence.

Invertebrates and microorganisms

Many different species of insects, other invertebrates, and microorganisms found throughout the impact area play significant roles in the biological communities. Some are important food for birds, frogs, toads, and small mammals, including bats. Larger insects, such as grasshoppers and beetles, are at times important food for foxes and coyotes. Other aquatic forms enter Lake Powell and become part of the food chain supporting fish life. Many invertebrates influence vegetation of the terrestrial habitat. Some are essential for pollination of plants. Others, such as ants, consume significant amounts of forage thus competing with other wildlife. A number of insects inhibit the growth of certain plants by inflicting injury. A list of invertebrates of the Kaiparowits area is found in Appendix II-16.

Many species of microorganisms (animal and plant growth, microscopic in size) occur in association with soils, vegetation, wildlife and domestic animals of the Kaiparowits Plateau. These organisms play a vital part in maintaining productivity of the habitat for larger wildlife. Some microorganisms, especially fungi, help decompose plant and animal matter for recycling into soil nutrients which were previously removed by vegetal growth. Some pathogenic organisms are an important factor in regulating populations of wildlife, particularly the small, highly prolific species.

Reptiles and amphibians

Thirty-two species of reptiles and amphibians have been identified in the impact area and on adjacent terrain. These include fourteen lizards, nine snakes, eight amphibians, and one turtle. A few of these species were recorded by earlier studies along the Colorado River before Lake Powell was formed and may no longer be present. Reptiles are widely distributed with some species occurring in virtually every type of habitat and topography. Two species of rattlesnakes, the

western rattlesnake and the shield-headed rattlesnake, and the collared lizard, add interest to the rocky terrain.

Reptiles and amphibians of the plateau include the following:

Lizards

collared lizard	tree lizard
long-nosed leopard lizard	side blotched uta
chuckwalla	short-horned lizard
speckled earless lizard	desert horned lizard
Utah spiny lizard	night lizard
plateau lizard	plateau whiptail
Great Basin sagebrush lizard	whiptail

Turtles

western painted turtle

Snakes

desert striped whipsnake	gopher snake
black-necked garter snake	king snake
wandering garter snake	Mesa Verde night snake
Mohave patch nosed snake	western rattlesnake
shield-headed rattlesnake	

Amphibians

tiger salamander	Rocky Mountain toad
western spadefoot toad	canyon tree frog
plains toad	cricket frog
red spotted toad	leopard frog

A more complete treatment of reptiles and amphibians is given in Appendix II-17

Aquatic species

Lake Powell, which lies within the zone of secondary influence is a major sport fishery. This large reservoir borders the impact area on the south and receives all runoff from the watershed in which the proposed plant and mine sites would be located.

The original warm, muddy, swift river habitat was converted to a relatively clear reservoir, approximately 150 miles long, by completion of Glen Canyon Dam in 1964. The complete alteration of habitat eliminated a number of fishes and other aquatic life formerly present, and made possible the introduction of a number of new species. Lake Powell is predominately warm water habitat. However, the deeper, colder waters are suitable for trout.

Principal game fish now found in Lake Powell include:

largemouth bass	black bullhead
walleye	rainbow trout
bluegill	brown trout
channel catfish	Kokanee salmon
yellow bullhead	black crappie

Striped bass have been planted in the reservoir recently. It is too early to determine the success of this introduction, but thus far growth has been excellent. For a complete list of fishes in Lake Powell see Appendix II-18

Fishing in Lake Powell is excellent, particularly for largemouth bass and crappie. The combination of good fishing and spectacular scenery attracts large numbers of fishermen from a wide multi-state area. In 1973, approximately 127,800 angler days were recorded on Lake Powell, with about 70,000 occurring in the lower portion of the reservoir served by Wahweap Marina.

In an extremely deep, steep-sided reservoir such as Lake Powell, much of the water is below the depth where enough sunlight can penetrate to produce small plant life essential to support fish and other aquatic animal life. Likewise,

much of the water is too deep for spawning fish such as largemouth bass. Thus, the limited area of shallow water spawning habitat is important. Wahweap and Warm Creek bays, immediately adjacent to the Kaiparowits Plateau impact area, contain significant areas of spawning habitat. Meaningful description or mapping of critical aquatic habitat in Lake Powell is infeasible because of fluctuating water levels and changing conditions. What is an important spawning area one year may be under water, 50 feet deep, a year or two later.

Tributary streams flowing into Lake Powell from the Kaiparowits Plateau are small and highly erratic in flow. The streams carry large freshets of silt laden water for short periods after rains and diminish to small trickles especially during hot, dry summer months. White deposits of salts and alkali are frequently visible on the mud flats along the stream courses at low flow. Most small springs and seeps, which provide base flows of the streams in dry weather are slightly to moderately saline, ranging from about 1,000 to more than 3,000 milligrams per liter of dissolved solids. As a result of these combined factors the streams provide virtually no habitat for fish.

Productivity of important warm water game fish spawning habitat found in coves where tributary streams enter Lake Powell probably results more from reservoir morphology and shallow water depths than from the erratic inflow from the tributaries.

A latent problem possibly exists for the Lake Powell sport fishery in the form of high mercury levels found in some of the larger game fish. The mercury comes largely from natural sources widespread throughout the watershed. Mercury tends to concentrate in organic material. Some of the mercury, which was carried downstream by the Colorado River prior to construction of Glen Canyon Dam now accumulates in organic sediments at the bottom of Lake Powell.

Mean mercury level of Lake Powell water is relatively low, about 0.01 part per billion (ppb), but the mercury is amplified through the food web until

a concentration of over 500 ppb occurs in the flesh of some larger individuals of largemouth bass and walleye, (Standiford 1973). This exceeds the level currently designated by the Food and Drug Administration as safe for human consumption.

The allowable mercury level of 500 ppb set by the United States Food and Drug Administration has been challenged by several investigators as being unnecessarily restrictive. This dissenting opinion is based largely on the premise that normally only a portion (frequently less than half) of the total mercury content in fish consists of methyl mercury, the biologically toxic form. The American Sport Fishing Institute has contended that an allowable level of 0.1 part per million (1,000 ppb) total mercury would contain an average of only 0.5 part per million (500 ppb) methyl mercury which would be within the limit safe for human health. Other studies (cited by Hesse et al., 1975) indicate that nearly all mercury in fish may be of the toxic methyl form.

Secondary influence zone

The most important area in the secondary influence zone is the adjacent mountain and foothill country northwest of the impact area. Much of this secondary influence zone is within boundaries of Dixie National Forest. Major topographic features are Boulder Mountain and the Aquarius, Sevier, and Paunsaugunt plateaus. These high, forested plateaus support excellent populations of wildlife, including mule deer, forest grouse, band tailed pigeons, and sage grouse. Small birds, predators, raptors, and fur animals are also present. One of the more significant populations of wild turkeys in Utah is found on the southern slopes of Boulder Mountain and the Aquarius Plateau. A number of shallow, marsh-bordered lakes and ponds on the Aquarius Plateau provide nesting habitat for waterfowl and shorebirds.

The Aquarius Plateau and Boulder Mountain contain a number of small lakes and reservoirs which provide fishing for cutthroat, brook, and rainbow

trout. Grayling have also been stocked in recent years in some of the lakes. Streams are few and small, but some provide limited trout fishing. Remote stream segments may contain a pure strain of the Colorado River cutthroat trout.

The Utah prairie dog, an endangered species, occurs in some northern portions of the secondary influence zone.

Recreational values of wildlife resources to man are primarily aesthetic and are influenced greatly by the setting in which found by the hunter, fisherman or other outdoor recreationist. Most wildlife in the secondary influence zone is found in conifer and aspen forests, open parks, and in meadows overlooking a vast panorama of rugged and colorful terrain encompassing two national parks. The combination of excellent wildlife habitat, spectacular scenery, and relatively natural uncrowded conditions makes the high plateaus immediately northwest of the primary study area one of the outstanding fish and wildlife areas of Utah.

The Henry Mountains, 60 miles northeast of the plant site, are another unique and valuable wildlife area in the zone of secondary influence. These large mountains, with free-roaming bison, are surrounded by desert and rugged terrain, presenting an exceptionally isolated and complete ecosystem.

Transmission system impact area

Summary

The proposed transmission system would pass through some wildlife habitat presently isolated from human use. Wildlife species such as desert bighorn sheep, desert tortoise, Gila monster, southern bald eagle and peregrine falcon require isolation for survival. The proposed transmission system would cross or by-pass crucial habitat for these species, plus the habitat for the mule deer, pronghorn antelope, elk, turkey, Gambel's quail, Abert's squirrel, waterfowl and shore birds.

The following endangered wildlife species are present along the proposed transmission system: brown pelican at Overton Wildlife Management Area and the

Colorado River; southern bald eagle, peregrine falcon, Moapa dace and woundfin in the Virgin and Muddy rivers; Colorado River squawfish in the Colorado River, and Gila topminnow in the Agua Fria River. The Vegas Valley leopard frog is classed as rare by Nevada. The prairie falcon, though not officially classed as rare, is sufficiently limited in numbers to merit special attention.

Proposed communication sites would be located on high ridges or mountain peaks - probable habitat for desert bighorn sheep. Habitat of game species is shown in Illustration II-25. Crucial areas for endangered, threatened, protected, and unique species are shown in Illustrations II-26 and II-27.

Big game

Mule deer - Kaiparowits-Phoenix route

Flat and Wild Steer mesas north and south of Highway 66 near Williams, Arizona, and the Black Mountains near Jerome, Arizona are crucial mule deer winter range. The remaining pinyon-juniper habitat throughout northern Arizona south of the Colorado River supporting scattered populations of mule deer are crucial mule deer winter or yearlong range.

Mule deer - Kaiparowits-Eldorado and Arizona Strip preferred alternate routes

Mule deer that inhabit Kaiparowits Plateau east of Kanab, Utah are discussed in the Kaiparowits Plateau impact area section.

Mule deer inhabit the Beaver Dam Mountains northwest of St. George in southwestern Utah and the Virgin Mountains in northwestern Arizona. The northern end of Beaver Dam Mountains is crucial winter range. Mule deer migrate into this area from the Virgin Mountains in Arizona and Red Mountains in Utah. Some deer migrate south across the proposed transmission route and the Arizona alternate preferred route to the summer range atop Black Rock and Virgin Mountains in Arizona. This range is crucial since it is the only summer range within 40 miles of the winter range on the Virgin and Red Mountains. Because of limited access to the

Virgin Mountains present populations and habitat are protected. The mule deer populations on the Kaibab National Forest and the Shivwits Plateau on the Arizona Strip route are known nationwide for producing most of the outstanding trophies of Boone and Crockett Registry quality for the State of Arizona.

West of Beaver Dam Mountains and north of Las Vegas, Nevada, mule deer inhabit isolated mountain ranges both north and south of the proposed right-of-way.

Mule deer - Kaiparowits to Moenkopi to Mohave route

Mule deer occur in a discontinuous manner along the route from Arizona State Highway 64, west to the Colorado River. The pinyon-juniper vegetative type on the Coconino Plateau, Hualapai Indian Reservation, Cottonwood, Peacock and Hualapai mountains are crucial mule deer habitat. Mule deer move northwest off the Sitgreaves Mountain, Kendrick Peak, and San Francisco Mountains, onto the plateau in the area west of Highway 64 and north of Highway 66. The Peacock and Hualapai mountains produce a sizable portion of the northern Arizona legal buck harvest.

Mule deer - Mohave-Serrano route

Mule deer are year-round inhabitants of mountains surrounding San Bernardino, California, and the Santa Ana and San Jacinto mountains east of Los Angeles. The proposed Mohave-Serrano transmission line would cross the Santa Ana Mountains and skirt the edge of the San Jacinto Mountains, both of which are important mule deer habitat.

Mule deer - Northern Kaiparowits-Mohave preferrred alternate

Only an occasional mule deer would be seen along the proposed Northern Kaiparowits-Mohave preferred alternate route.

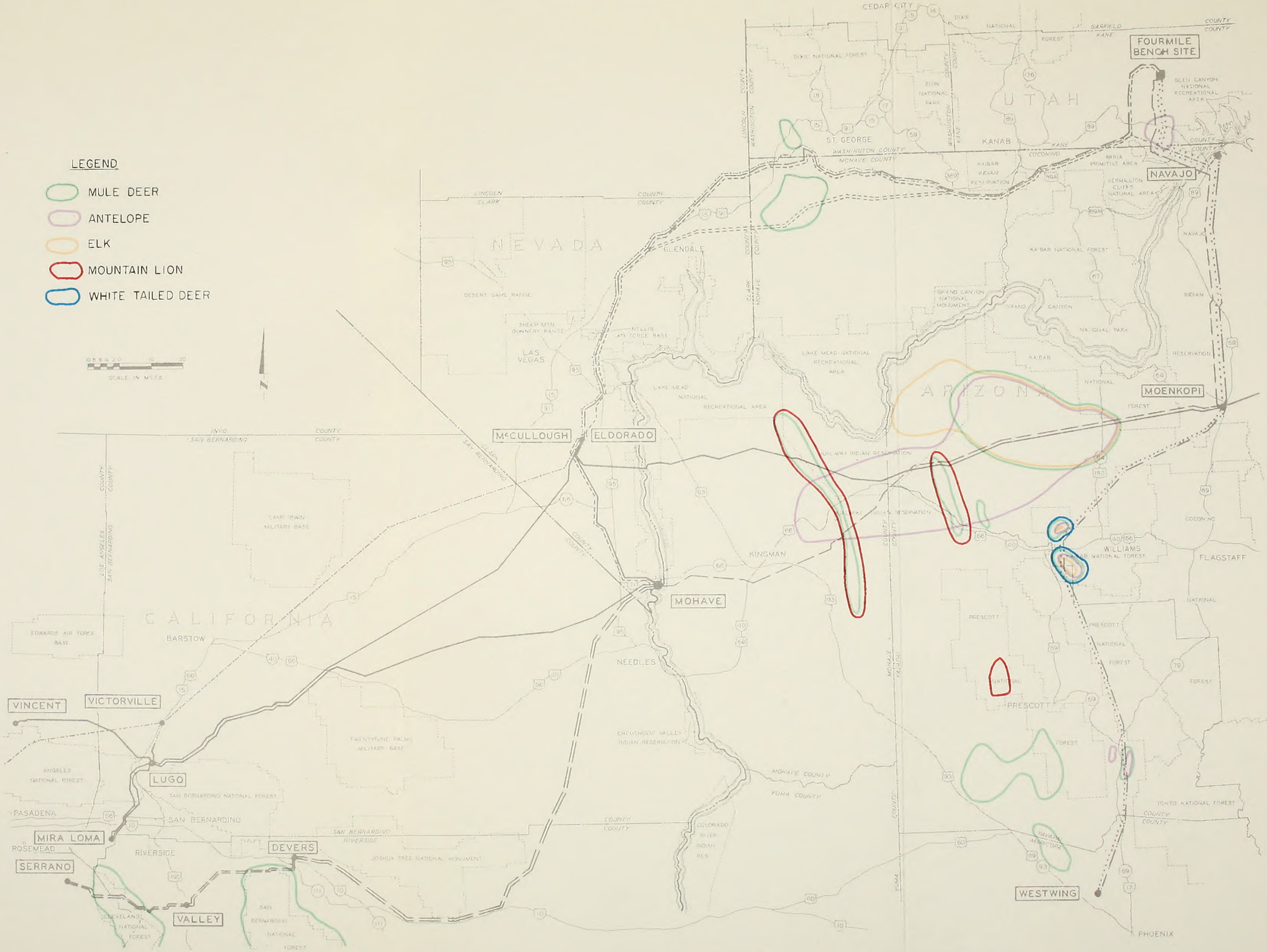


ILLUSTRATION II-25

Wildlife - Crucial Game Species Habitat

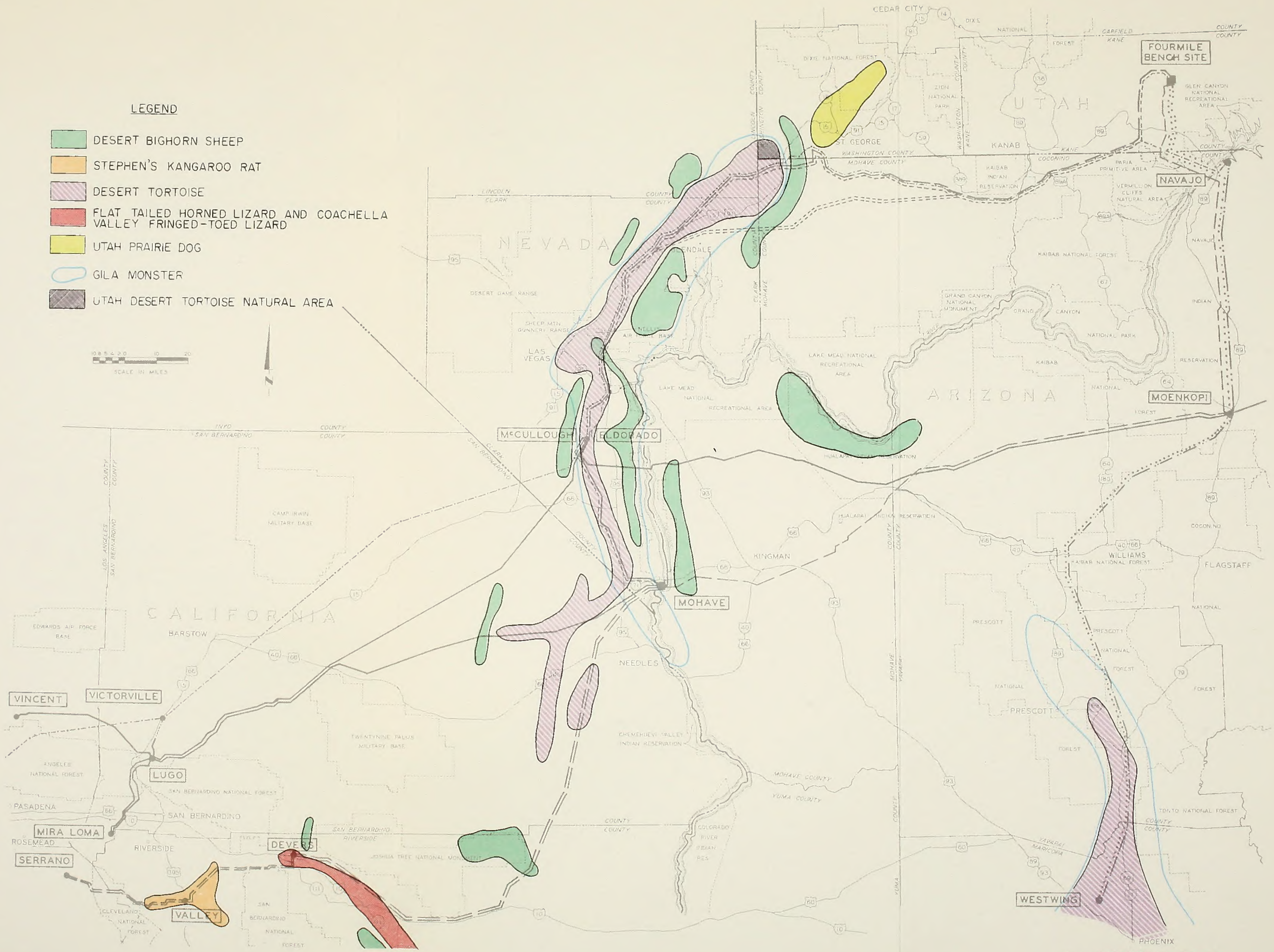


ILLUSTRATION II-26

Wildlife - Endangered, Threatened, Protected and Unique Crucial Areas - I

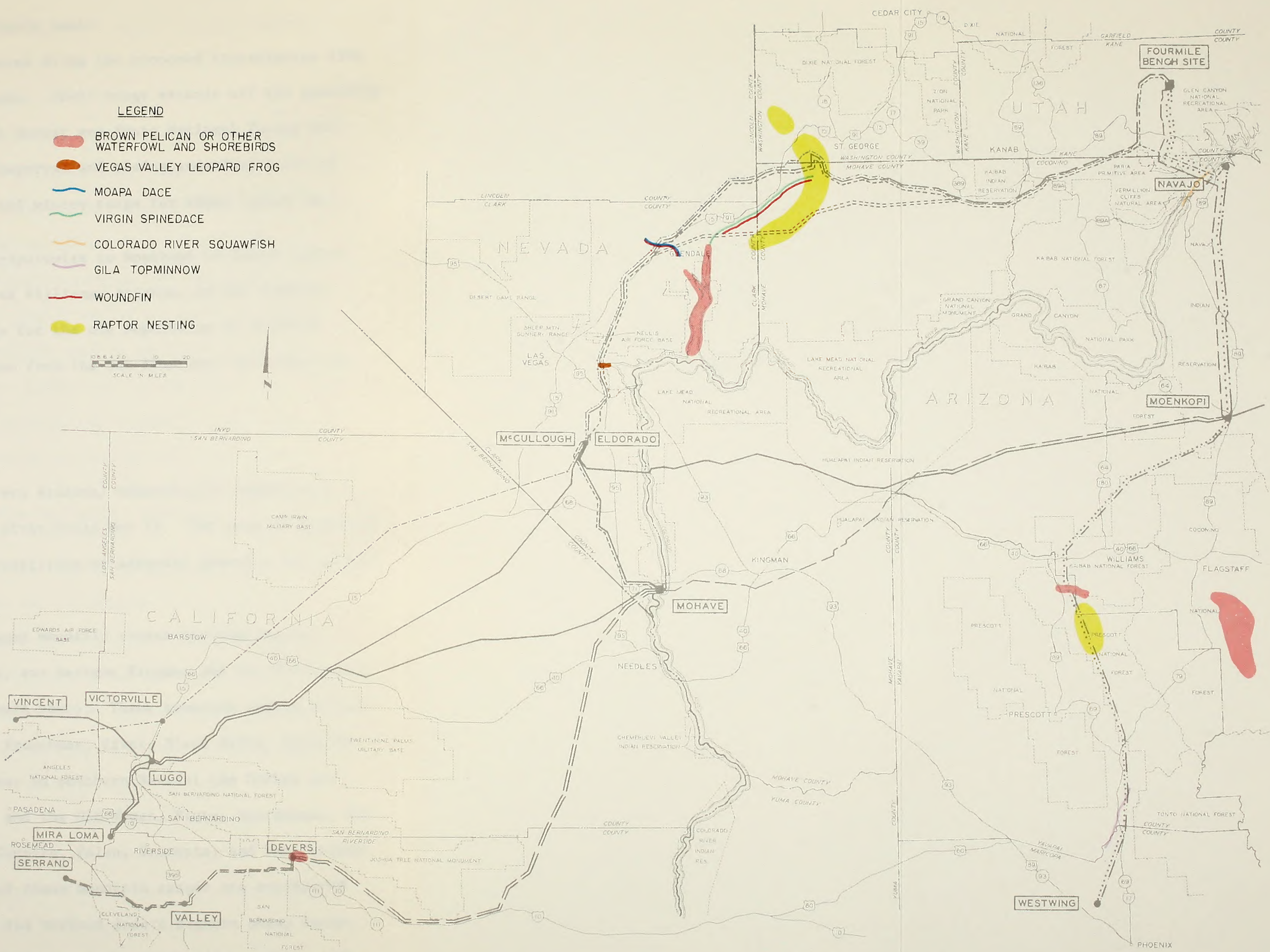


ILLUSTRATION II-27

Wildlife - Endangered, Threatened, Protected and Unique Crucial Areas - II

Whitetail deer - Kaiparowits-Phoenix route

Whitetail deer are found in only a few places along the proposed transmission line from Williams south to Rock Springs, Arizona. Their range extends off the mountains in the eastern sector of Prescott National Forest and Tonto National Forest into pinyon-juniper near Willims and Rok and chaparral and plains grassland south of Rok. Flat and Wild Steer mesas are critical winter range for white tailed deer.

Elk - Kaiparowits-Phoenix and Kaiparowits to Moenkopi to Mohave routes

The Coconino Plateau northwest of Williams, Arizona, on the Hualapai Indian Reservation is crucial winter range for the elk population in northern Arizona. Elk migrate onto Coconino Plateau from the San Francisco Mountains and Kendrick Peak.

Bighorn sheep - all routes

The Virgin Mountains (northwestern Arizona) historically supported a population of desert bighorn sheep until after World War II. The area is presently excellent desert bighorn sheep habitat, consisting of adequate quantity and quality of food, water and cover.

The isolated, inaccessible, rugged mountain ranges surrounding Las Vegas, north and west of Kingman, Arizona, and between Kingman and San Bernardino, California, presently support desert bighorn sheep. These mountain ranges include the Mormon, Meadow, Muddy, Arrow Canyon, Frenchman, River, Black Hills, Eldorado, McCullough, Newberry and Highland mountains in southern Nevada; the Cerbat and Black mountains in northwestern Arizona; and the Old Woman, Piute, Sacramento, San Bernardino, Eagle, Coxcomb, Chuckwalla, Granite, Palen, Orocopia, and San Jacinto mountains in southern California. Most of these mountain ranges are considered crucial habitat, absolutely necessary to the various desert bighorn sheep bands. The only bighorn sheep habitat in these areas is on the steep sides and tops of

these mountain ranges. Bighorn sheep currently migrate across the proposed transmission line corridor between the mountain ranges.

Within the River Mountains, Black Hills and McCullough range, bighorn sheep migrate into the River Mountains to lamb because of available water and succulent forage. When water in the River Mountains is unavailable, the sheep migrate into the Black Hills where longer seasonal waters and succulent vegetation remain in the higher elevations and deeper soils on the west side of the hills. Bighorn sheep then migrate to the McCullough Range late in the summer. Highland Range supports one of the largest desert bighorn sheep populations in southern Nevada. The Bureau of Land Management has written a habitat management plan to maintain and improve the habitat for this national interest wildlife species. Bighorn sheep inhabit that portion of the proposed route which crosses the roadless Coxcomb Mountains and skirts the northern edge of the San Jacinto Mountains.

Antelope - Kaiparowits-Phoenix, Kaiparowits-Eldorado,
Kaiparowits to Moenkopi to Mohave routes

Antelope are widely distributed and highly mobile. Antelope seasonally enter nearly all segments of the proposed route from Page to Phoenix, Arizona, except those that pass through the rugged mountains and Mohave desert scrub.

The Coconino Plateau near Williams, Arizona and from Page, Arizona to the Peacock Mountains, 20 miles northeast of Kingman, provides range for antelope with a wide variety of cured grasses and forbs. The Coconino Plateau provides crucial winter antelope habitat. This portion of the antelope habitat is the most important in Arizona.

The Sycamore, Perry's and Black mesas north of Phoenix support small populations of antelope. This area is crucial to the survival of these herds.

The small population of antelope of East Clark Bench east of Kanab, Utah, is discussed in the Kaiparowits Plateau impact area.

The area from the Utah-Arizona state line south of Kanab, west to the Hurricane Cliffs is potential antelope habitat. Historically, antelope inhabited this range and produced the largest trophy antelope in the United States. At present, small isolated bands descended from transplanted antelope inhabit the area.

Peccary - Kaiparowits-Phoenix and Kaiparowits to Moenkopi to Mohave routes

Peccary, (Javelina), range along the proposed Kaiparowits-Phoenix route south from Mayer (60 miles north of Phoenix, Arizona). The northern one-third of this route is mesa plains grassland. Peccary in this area are found in small rugged canyons incised across these mesas by Ash, Sycamore, Bishop, Tank, and Squaw creeks and along the Agua Fria River. South of the mesas along the proposed Kaiparowits-Phoenix corridor, peccary would more likely be found in hilly portions of the Arizona upland subdivision of the Sonoran desert scrub as far south as Lake Pleasant, rather than in the flatter desert to the south. Peccary have been introduced into Cottonwood Wash, along the Kaiparowits to Moenkopi to Mohave route, 25 to 30 miles east of Kingman.

Mountain lion - all routes

Mountain lions are sparsely but widely distributed in the general area of the proposed transmission routes, primarily in more rugged terrain throughout Arizona and Utah. The Music Mountains-Cottonwood Mountains-Aquarius Mountain complex probably supports one of the largest mountain lion populations in Arizona. Stable animal populations also inhabit the Cottonwood Cliffs, the Peacock, Hualapai and Black mountains, and the more rugged areas between Highway 64 and the Haulapai Indian Reservation. The Aubrey Cliffs provide good habitat for the mountain lion because of the high deer population. Mountain lions are also found throughout the

Kaiparowits Plateau with the greatest numbers in the Fiftymile Mountain area, and in the Beaver Dam and Virgin mountains west of St. George, Utah.

Turkey - Kaiparowits-Phoenix and Kaiparowits-Moenkopi-Mohave routes

Range of the turkey may extend from as far north as Cameron, Arizona, in the Navajo Indian Reservation, south to Cordes Junction, Arizona, and on the Hualapai Indian Reservation south of the Colorado River. The turkey can be found in pinyon-juniper, ponderosa pine, chaparral, streams and washes with trees, and in edge areas of plains grassland adjacent to wooded areas. The Coconino Plateau is an important winter range for turkeys where forage is available during the winter. Summer range for the turkey is predominately in ponderosa pine timber interspersed with open parks and meadows. Winter range is usually grassland, pinyon-juniper and chaparral habitats at lower elevations.

Upland game

Mourning dove - all routes

Mourning dove are present for short periods of time during the summer and fall along the proposed transmission line routes through southern Utah and Nevada and northern Arizona. Along the proposed transmission line in southern California and on the Mohave Desert in Arizona mourning doves are year-round residents.

White-winged doves - all routes

White-winged doves inhabit the area from Prescott, Arizona, south to Phoenix, in areas along the Virgin and Moapa rivers south to Las Vegas, Nevada, and in the vicinity of the Coxcomb Mountains near Desert Center, California. Except for a few early arrivals and a few stragglers, the white-winged dove can be seen in Arizona and Nevada only during the breeding season from May to September.

Chukar - Kaiparowits-Phoenix and Kaiparowits-Eldorado routes

Chukar partridge inhabit the rugged, rocky portion of the proposed Kaiparowits-Eldorado route which runs north of Kaibab National Forest and south of the Utah-Arizona state line. Chukars have been planted in many Mohave Desert mountain ranges. However, the only known successful introduction has been on the northern Piutes.

Gambel's quail - all routes

Gambel's quail can be found in desert grasslands, pinyon-juniper, mesquite, and along streams and washes. The quail range along the Agua Fria River, across the Coconino Plateau west to Kingman and in the Sonoran and Mohave deserts. A small population inhabits Paria Canyon east of Kanab, Utah, where the canyon is crossed by U.S. Highway 89, and a large population occurs in lowlands along Kanab Creek, south of Kanab. Where habitat is suitable, Gambel's quail are also found from Hurricane Cliffs near Hurricane, Utah, west to south of Las Vegas. Small isolated populations of Gambel's quail inhabit areas around desert water holes throughout the Mohave Desert and westward to Palm Springs, California.

California and Mountain quail - Mohave-Serrano route

California and Mountain quail inhabit the Santa Ana Mountains east of Los Angeles. Mountain quail also inhabit Joshua Tree National Monument. These quail are found along streams where vegetation is available for food and where high riparian cover is suitable for nesting and roosting.

White-winged pheasant - Kaiparowits-Eldorado route

White-winged pheasants inhabit virtually all farm land along the Virgin River from Mesquite, Nevada to south of Riverside, Nevada. This species is dependent upon farm waste grain. Cover must also be available.

Band-tailed pigeon - all routes

Band-tailed pigeons are found in Arizona from where the proposed transmission route leaves the Navajo Indian Reservation, south to Rock Springs, Arizona, in the Virgin and Black Rock mountains of northwestern Arizona near St. George, Utah. The birds are also found in the Santa Ana Mountains near Los Angeles, California. Band-tailed pigeons nest in the Virgin and Black Rock mountains. Large flocks winter in the Santa Ana Mountains. This species requires ponderosa pine trees for nesting.

Cottontail rabbits - all routes

Cottontail rabbits are found along the entire proposed transmission system wherever there is sufficient brush for cover and ground vegetation for food. The rabbits preferred habitat is along rocky ledges and creek banks. They also become well established in pinyon-juniper chained areas where downed material provides cover.

Brush rabbits - Mohave-Serrano route

Brush rabbits are found in chaparral habitat in the Mohave Desert.

Black tailed jackrabbits - all routes

Black tailed jackrabbits inhabit the entire length of the proposed transmission system where suitable brush cover and vegetation occurs.

Abert's squirrel - Kaiparowits-Phoenix route

Abert's squirrel inhabits ponderosa pine areas between Prescott and Flagstaff, Arizona, and pockets of ponderosa pine south of Highway 66 in Arizona. The Black Rock Mountains in northwestern Arizona are potential Abert's squirrel habitat. This species requires ponderosa pine forests.

Waterfowl and shorebirds - all routes

Waterfowl and shore birds inhabit stock ponds throughout Arizona, southern Nevada, southern Utah, and southern California when water is present. There is limited waterfowl and shorebird habitat along the proposed route from Page, Arizona, to Phoenix. The Virgin and Muddy rivers in southern Nevada provide winter nesting areas for many species of waterfowl and shorebirds. Most of the habitat in southern Nevada and western Arizona are on the Overton Wildlife Management Area and Lake Mead.

There are no major waterfowl concentration areas along the proposed transmission route in southern California. However, ponds at Thousand Palms Canyon near Thousand Palms, California, and other springs in the area attract waterfowl and shorebirds. These ponds are less than 1/4 mile from the proposed transmission line.

Nongame species, including birds of prey

Birds of prey - all routes

Birds of prey (raptors) that inhabit lands along the proposed transmission system include two species of eagles, including both southern and northern subspecies of bald eagles, 10 species of owls, and 14 species of hawks and falcons (see Appendix II-19). Many of these birds occur along grassland, desert scrub, pinyon-juniper woodland, and areas of low vegetation. Most are not restricted to any specific habitat type and, therefore, enjoy a broad distribution. Raptors observed along the proposed transmission line from June 1 to July 15, 1974, by the participants' biologist included the red-tailed hawk, Cooper's hawk, American kestrel, burrowing owl, Swainson's hawk and the golden eagle. Several species occur in the southwest only at certain times of the year.

The golden eagle, protected under federal law, inhabits southern Utah, southern Nevada, and northern Arizona during the winter months. The northern bald

eagle winters in southern Utah on Kaiparowits Plateau, in the Lake Powell area, and along the Verde River. The endangered southern bald eagle resides along Lake Mead and the southern Colorado River, and in southern California. One of the raptor nests along the Verde River may belong to an endangered southern bald eagle. This is indicated by the size and structure of the nest.

Peregrine and prairie falcons are year-round residents along the proposed transmission system. These species prefer higher bench lands and canyons in southern Utah and Nevada, northern Arizona, and southern California. The peregrine falcon is classed as endangered. The prairie falcon was included in the 1973 list of threatened wildlife.

Black hawks, a peripheral species, nest along the Agua Fria River south of Rock Springs, Arizona.

The sharp-shinned hawk, marsh hawk, and ferruginous hawk are spring and summer residents of higher elevations north and east of the Colorado River. These hawks have been observed in low-lying areas of desert scrub and in creek flood plains. The red-tailed hawk, American kestrel and Cooper's hawk are summer residents within the same area.

The ferruginous hawk was formerly a common winter resident in the area of the Mohave Desert crossed by the proposed line, but is now uncommon in this area. The red-shouldered hawk was also once common in southern California, but recently has become rare in the area.

The Cedar Wash and Dog Leg Canyon in the Beaver Dam Mountains of Utah and the Virgin Mountains of Arizona are crucial cliff-nesting habitat for raptors. The proposed line and the preferred Arizona Strip alternate traverse these areas. The area where the Kaiparowits-Phoenix route crosses the Verde River is crucial habitat for raptors.

The great horned owl prefers cliffs and canyons; the long-eared owl inhabits the pinyon-juniper woodland; and the burrowing owl prefers to nest in

road banks and in abandoned rodent burrows. These owls are year-round residents of the Kaiparowits basin and of the entire proposed transmission line corridor, but are not frequently observed.

Nongame birds other than raptors - all routes

Although birds are seldom seen in large numbers at any one given time or place (except in the Overton Wildlife Management Area) more than 328 species can be found along the transmission line corridor during the year. The species are listed in Appendix II-19 and summarized in Figure II-39.

A greater variety of birds occurs in the southern half of Arizona where warm weather conditions are conducive to year-round habitation. Also, a greater variety of birds occurs within the riparian habitat along the Colorado River, Overton Wildlife Management Area, Verde River, Virgin River, and Muddy River where habitat diversity is the greatest. The Black Rock and Virgin mountains are diverse pristine habitat supporting a wide variety of terrestrial birds. Thousand Palms Canyon and the springs south of Indio Hills contain the only water holes in the area and support a wide diversity of water-associated bird life.

Limited information is available for that portion of the route through the Navajo Indian Reservation. However, the more conspicuous nongame birds and raptors in that area are the roadrunner, pinyon jay, raven, and turkey vulture.

Nongame mammals (general) - all routes

There are at least 123 different species of mammals along the proposed transmission line system. These species are listed in Appendix II-20 and summarized in Figure II-40.

Nongame mammals (predators) - all routes

Coyotes, bobcats, badgers, gray fox, red fox, and kit fox reside along the entire proposed transmission line system where specific habitat requirements

FIGURE II-39

Birds Found Along the Proposed Kaiparowits Transmission System

Common Family Name	Scientific Family Name	Number of Species
Loons	Gaviidae	2
Grebes	Podicipedidae	4
Pelicans	Pelecanidae	2
Cormorants	Phalacrocoracidae	1
Herons and bitterns	Ardeidae	9
Wood ibises	Ciconiidae	1
Ibises	Threskiornithidae	1
Swans, geese and ducks	Anatidae	30
Vultures	Cathartidae	1
Hawks, harriers and eagles	Accipitridae	12
Osprey	Pandionidae	1
Falcons	Falconidae	2
Grouse	Tetraonidae	1
Quails, partridges and pheasants	Phasianidae	7
Turkeys	Meleagrididae	1
Cranes	Gruidae	1
Rails, gallinules and coots	Rallidae	4
Plovers	Charadriidae	4
Snipes, sandpipers, etc.	Scolopacidae	17
Avocets and stilts	Recurvirostridae	2
Phalaropes	Phalaropodidae	2
Gulls and terns	Laridae	8

(Continued)

FIGURE II-39

Birds Found Along the Proposed Kaiparowits Transmission System (Continued)

Common Family Name	Scientific Family Name	Number of Species
Pigeons and doves	Columbidae	7
Cuckoos and roadrunners	Cuculidae	2
Owls	Tytonidae and Strigidae	10
Goatsuckers	Caprimulgidae	4
Swifts	Apadidae	2
Hummingbirds	Trochilidae	7
Kingfishers	Alceninidae	1
Woodpeckers	Picidae	13
Tyron and flycatchers	Tyrannidae	17
Larks	Alandidae	1
Swallows	Hirundinidae	7
Jays, magpies, and crows	Corvidae	7
Titmice, verdins, bushtits	Paridae	4
Nuthatches	Sittidae	3
Creepers	Cethiidae	1
Wrentits	Chamaeidae	1
Dippers	Cinclidae	1
Wrens	Troglodytidae	7
Mockingbirds and thrashers	Mimidae	9
Thrushes, bluebirds and solitaires	Turdidae	9
Gnatcatchers and kinglets	Sylviidae	4
Pipits	Motacillidae	1

(Continued)

FIGURE II-39

Birds Found Along the Proposed Kaiparowits Transmission System (Concluded)

Common Family Name	Scientific Family Name	Number of Species
Waxwings	Bombycillidae	2
Silky flycatchers	Pitilogonatidae	1
Shrikes	Lanaiidae	2
Starlings	Sturnidae	1
Vireos	Vireonidae	6
Wood warblers	Parulidae	26
Weaver finches	Ploceidae	1
Meadowlarks, blackbirds and orioles	Icteridae	11
Tanagers	Thraupidae	3
Grosbeaks, finches sparrows, and buntings	Fringillidae	44

FIGURE II-40

Mammals Found Along the Proposed Kaiparowits Transmission System

Common Name	Scientific Family Name	No. of Species
Opossums	Didelphiidae	1
Shrews	Soricidae	8
Moles	Talpidae	1
Leafnose bats	Phyllostomidae	1
Plainnose bats	Vespertilionidae	17
Freetail bats	Molossidae	3
Bears	Ursidae	1
Raccoons	Procyonidae	1
Ringtails	Bassariscidae	1
Weasels, skunks, etc.	Mustelidae	7
Dogs, foxes	Canidae	4
Cats	Felidae	2
Squirrels	Sciuridae	20
Pocket gophers	Geomyidae	1
Pocket mice, kangaroo mice, and kangaroo rats	Heteromyidae	20
Beaver	Castoridae	1
Mice, rats, vole	Cricetidae	21
Old World mice	Muridae	1
Porcupine	Erethizontidae	1
Hares and rabbits	Leporidae	5
Peccaries	Tayassuidae	1
Deer	Cervidae	3
Pronghorn	Antilocapridae	1
Sheep	Bovidae	1

are met. The habitat requirements of coyotes, bobcats, badgers and gray fox are discussed in the Kaiparowits Plateau impact area section. Red fox require sparsely populated areas with a mixture of forest and open country. Kit fox inhabit open, level, sandy ground, preferably with low desert vegetation. They inhabit borders of open valley bottoms. Interactions between predator species and populations of small mammals, birds, and reptiles are discussed in the Kaiparowits Plateau impact area section.

Other mammals - all routes

The variation from harsh, arid terrain of southern Utah, southern Nevada, Arizona and southern California to the lush humid area along the Pacific Coast provides habitat for a wide variety of small mammals. In the arid areas, the population of small mammals is characterized by a great diversity of species rather than by large numbers of individuals. In the more humid areas, such as riparian habitat, coastal sage-scrub, and coastal chaparral, higher densities of individual species occur. General habitat requirements of most of these small mammals are discussed in the Kaiparowits Plateau impact area section. The Black Rock and Virgin mountains are diverse pristine habitat areas supporting a wide variety of terrestrial mammals. Thousand Palms Canyon and the springs south of Indio Hills are the only water holes in the area and these watering places support a wide diversity of water-associated mammal life.

In western California, opossums occur primarily along farming areas. In other areas, they can be found in woodlands and along streams. The shrew habitat varies from wet wooded areas and along streams to dry alluvial fans and chaparral slopes. The vegetative type habitat varies from conifer forests to sagebrush and other low desert shrubs. The single species of mole found along the proposed transmission system inhabits porous soils in the valleys and meadows in the mountains of northern California.

Black bear inhabit the mountains of southern Utah, northern Arizona, and central California. Raccoons occur along streams and rivers throughout this entire area. Ringtails reside in the area where the proposed transmission line would cross perennial streams or rivers with riparian vegetation and rocky ledges and cliffs. Longtail weasels inhabit all areas that are near water throughout most of southern Utah, southern Arizona, and southern California. River otters are found along the Colorado River. Skunks inhabit semiopen country, mixed woods, brushland and open prairie normally within 2 miles of water. Badgers, coyotes, foxes, mountain lions and bobcats are discussed in the Kaiparowits Plateau impact area section and in the predators section.

Various ground squirrels and chipmunks inhabit virtually all vegetative areas along the proposed transmission system. A few species are found only in specialized habitat. Pocket mice, kangaroo mice, and kangaroo rats inhabit areas of various vegetative growth. Beaver can be found along streams and rivers crossed by the proposed transmission system. Mice, rats, and moles also inhabit various vegetative type areas along the route. Porcupine usually live in forested areas, but occasionally can be found some distance from trees where brush is available. Rabbits occur in all habitat types.

Threatened or unique species

Threatened or unique wildlife species (and protected wildlife species) are listed in Appendix II- 21.

Mammals - all routes

The spotted bat, listed as a threatened species within the United States, has been reported along the proposed transmission system. However, very little is known about the habitat requirements of the species.

Although the black-footed ferret has not been seen for years in the Navajo Indian Reservation or in the prairie dog inhabited grasslands near Williams,

Arizona, in the area of the proposed corridor, it is possible a few still live in prairie dog towns in the area. The black-footed ferret is apparently entirely dependent on prairie dogs for survival although it may eat any small prey it can catch. Preservation of prairie dog towns, therefore, helps to ensure survival of the black-footed ferret.

The Utah prairie dog is a colonial inhabitant in open or slightly brushy country, in scattered juniper-growth areas, and among pines in Washington County, Utah, along and north of the proposed transmission line route.

Stephen's kangaroo rat can be found along the proposed route in San Jacinto Valley, California. This animal has been identified by the California Department of Fish and Game (1974) as a rare species. Urbanization and land use changes have destroyed most of the original habitat of the Stephen's rat. It is found now in only 15 isolated localities in Riverside County and one in San Diego County.

Birds - all routes

The endangered brown pelican is an occasional occupant of the Overton Wildlife Management Area and the lower Colorado River. Habitat requirements of this species are discussed with other waterfowl and shorebirds.

Range of the endangered southern bald eagle is region-wide except for the Kaiparowits Plateau. Range of the endangered peregrine falcon is also region-wide. Survival of the bald eagle and peregrine is dependent upon suitable nesting sites and wintering habitat away from human disturbance. There is suitable nesting habitat for both species along the proposed transmission system in cliff areas of the Navajo Indian Reservation, in mountain and canyon areas of the Kaibab and Prescott National forests, in cliffs on the Verde, Virgin, Muddy, and Colorado rivers, and in cliffs of the San Jacinto Valley in California.

The mountain plover (status undetermined) and the California yellow-billed cuckoo are found in small numbers throughout the Mohave Desert.

Reptiles and amphibians - all routes

The Vegas Valley leopard frog is located only in the Las Vegas Wash. This species, which may already be extinct, requires permanent water. The proposed transmission line crosses the species habitat.

Small numbers of the Gila monster inhabit canyon bottoms and dry washes in the Sonoran and Mohave deserts. Increasing human pressure and activity in the desert is detrimental to this species. Cedar Wash in the Beaver Dam Mountains is a crucial habitat supporting a high density of this species.

Fish

Kaiparowits-Phoenix, Kaiparowits-Navajo,
Kaiparowits-Eldorado and Arizona Strip preferred alternate routes

The Virgin River spinedace inhabits the Virgin River. This species is protected by the Nevada Department of Fish and Game.

The woundfin inhabits the sediment-laden waters of the Virgin and Muddy rivers and the Moapa dace inhabits the Muddy River. Populations of these fishes have been greatly reduced by man's activities. Both are classified as endangered by the U.S. Fish and Wildlife Service.

The Colorado River squawfish was once a dominant fish in the Colorado River. As the top predator, it reached lengths of 3 to 4 feet. In recent years, due to habitat alteration caused by dams on the river, the fish has become nearly extinct. Apparently, one of the few places the fish still survives in Arizona is in the area of the proposed powerline crossing of the Colorado River.

The Gila topminnow was recently introduced into the Agua Fria River upstream from Lake Pleasant. This fish may have migrated upstream during high water to where the proposed line would cross the river between Cordes Junction and Rock Springs. Although the Agua Fria does not flow year-round in this stretch, there may be small pools and pockets of water where this fish could survive from year to year.

Invertebrates and microorganisms - all routes

A great diversity of invertebrates and microorganisms exists along the proposed transmission line system. Classes or families of invertebrates identified along the Arizona segment of the proposed transmission line system are shown in Appendix II-22. Classes or families of invertebrates identified in the Kaiparowits basin area are shown in Appendix II-16. Greatest diversity of invertebrates and microorganisms occurs along riparian habitat in the Colorado River, Virgin and Muddy rivers in Nevada, Thousand Palms Oasis, Push Walls Canyon, and Willow Hole, near Palm Springs, California, and at other springs and waterholes along the proposed transmission line route.

Reptiles - all routes

Vegetative diversity along the proposed transmission system supports an equally diverse reptile fauna. There are at least 58 different species of reptiles along the proposed system. The various species are listed in Appendix II-23 and summarized by families in Figure II-41.

FIGURE II-41

Summary of Reptiles Along the Proposed Transmission Line

Family Name	Number of Species
Tortoise	1
Lizards	29
Snakes	28

The Gila monster ("status-undetermined" in the threatened wildlife of the United States) is discussed under threatened species in the section above.

The desert tortoise inhabits virtually all areas of the lower Sonoran and Mohave deserts eastward to the Virgin and Beaver Dam mountains in southern Utah and northern Arizona, westward throughout the Mohave Desert to east of San Bernardino, California, and in the flat mesa land from Prescott to Phoenix, Arizona. The tortoise is normally found near desert oases, washes, and sand dunes. Habitat along the proposed transmission system in Utah, Arizona, and California is considered crucial. The desert tortoise dens up during winter and during dry periods.

Because of its large size and slow movements, the desert tortoise has been exploited by man for many years. Recently, with increased human activity in the deserts, this species has suffered considerably. Its range is probably not diminishing, but its numbers are declining rapidly. Many have been removed for use as pets and many have been killed by off-road vehicles. Desert tortoise have fallen into pit reservoirs where they eventually succumb to the elements. The desert tortoise is classified as rare by the State of Nevada and is protected in Arizona, California, Nevada and Utah. The Beaver Dam Wash area is a crucial habitat for a concentrated population of desert tortoise. This area is under study by the Bureau of Land Management for designation as a natural area in order to protect the habitat of the desert tortoise.

The Arizona night lizard, although not protected by state or federal law, has a limited distribution in the Southwest and may occur along the proposed transmission line system.

The flat-tailed horned lizard is restricted to areas with sparse vegetation and fine sand along the proposed transmission route in the vicinity of Indio, California. This species has become more rare in recent years. The Coachella Valley fringe-toed lizard is found in similar habitat in the same general area. It likewise, has become rare in recent years. Decline of both species has been attributed in part to habitat destruction by development and by off-road vehicles.

The granite night lizard is found in the San Gorgonio Pass area. It has declined in recent years due to habitat destruction and exploitation by collectors.

Aquatic species - all routes

Major waters inhabited by aquatic animals along the proposed route are shown in Figures II-42 and II-43.

Virtually all species of life encountered along the transmission line route are directly or indirectly dependent upon an open water supply. Some plants and smaller organisms are dependent upon particular water holes and springs. There are many types of aquatic species that spend a part or all of their lives in water. Most of these animals require rather specific habitat conditions. Freshwater animals include simple forms, such as protozoans and rotifers; intermediate complex forms, such as flat worms, round worms, and aquatic counterparts of earthworms; and complex forms, such as clams, snails, insects, crustaceans (shrimp and crawdads), and fishes. Except for fishes, not much information is available on aquatic animals in the proposed transmission route area. These groups of animals exist in a complex environment with generally well-developed and interrelated predator-prey relationships. Changes in certain prey populations caused by habitat alteration can affect predator populations even though the predators would otherwise be able to exist in the altered environment. All of the above types of animals may exist in the waters crossed by the proposed route.

Amphibians - all routes

The species list of amphibians is shown in Appendix II-23. Figure II-44 is a summary of amphibians along the proposed transmission route.

FIGURE II-42

Major Perennial Streams and Lakes Along Proposed Transmission Line Route

Name of Major Waters	Arizona	California	Nevada	Utah
Colorado River	X	X	X	X
Little Colorado River	X			
Verde River	X			
Agua Fria River	X			
Virgin River	X		X	
Muddy River			X	
Lake Mead	X		X	
Lake Powell	X			X
Thousand Palms Oasis		X		

FIGURE II-43

Streams and Washes Containing Year-Round Water

Arizona	Southern Nevada
Little Colorado River	Toquop Wash
Hells Canyon	Meadow Valley Wash
Ash Creek	California Wash
Little Ash Creek	Vegas Wash
Dry Creek	**California**
Yarber Wash	Thousand Palms Canyon
Sycamore Creek	Willow Hole Wash
Indian Creek	Macomber Palms
Silver Creek	Biskra Palms
Bishop Creek	
Tank Creek	
Squaw Creek	
Little Squaw Creek	
Aqua Fria River	
Several unnamed washes incising Perry's Mesa south of Joe's Hill	

Southern Utah to Northern Arizona

Wahweap Creek

Paria Canyon

Cottonwood Wash

White Sage Wash

Johnson Wash

Kanab Creek

Beaver Dam Wash

FIGURE II-44

Summary of Amphibians Along the Proposed Transmission Line

Family Name	Number of Species
Salamanders	5
Toads	7
Frogs	7

Frogs are restricted to permanent water more so than toads. Toad species are restricted to water during egg and tadpole (polliwog) stages. Toads live on land as adults and often migrate considerable distances from water to find cool places to hide. (The Vegas Valley leopard frog is discussed in the threatened species section.)

Fish - all routes

A complete list of fish found along the proposed transmission routes is shown in Appendix II-24, and summarized in Figure II-45.

There are no known game or nongame fishery resources between the proposed Kaiparowits generating station and the Colorado River. The fish listed in Figure II-46 are known to occur in the Colorado River downstream from the Glen Canyon Dam near the proposed transmission line crossing.

Of the fish listed in Figure II-46, the catfish, bullhead, and trout are game fish. The Colorado River squawfish is a threatened species. There are no known game or nongame fisheries along the proposed transmission line that would cross the Navajo Indian Reservation.

FIGURE II-45

Summary of the Fishes Found Along the Proposed Transmission Routes

Family Name	Number Species
Shad	1
Salmon and trout	4
Carps and minnows	11
Suckers	2
Catfish	3
Livebearers	2
Sunfish	4
Perch	1

Game fish found in the Verde River near the proposed crossing are channel catfish, yellow bullhead, smallmouth bass, and rainbow trout. Nongame fish reported in the same area are the longfin dace, fathead minnow, Gila sucker, Gila mountain-sucker, and mosquitofish. None of these fish are considered endangered. No game fish occur in the Agua Fria River where the proposed route would cross several times between Cordes Junction and Rock Springs. In recent years, two minnows each of the (the Gila chub and the longfin dace) species have been caught in the Agua Fria River near Cordes Junction and Rock Springs. The Agua Fria River in these areas apparently retains enough water in small pools and pockets year-round to sustain populations of these small minnows. The Gila topminnow (discussed in the threatened species section) possibly has expanded its range upstream to the area of these crossings.

FIGURE II-46

Fishes of the Colorado River Found Near the Proposed Transmission Line Crossing

Common Name	Scientific Name
Threadfin shad	Dorosoma petenense
Carp	Cyrpinus carpio
Golden shiner	Notemiqonus crysoleucus
Bonytail chub	Gila elegans
Colorado River chub	Gila robusta
Colorado River squawfish	Ptychocheilus lucius
Speckled dace	Rhinichthys osculus
Red shiner	Notropis lutrensis
Razorback (humpback) sucker	Xyrauchen texanus
Flannelmouth sucker	Catostomus latipinnis
Bluehead mountain sucker	Pantosteus discobolus
Rainbow trout	Salmo gairdneri
Channel catfish	Ictalurus punctatus
Black bullhead	Ictalurus melas
Yellow bullhead	Ictalurus natalis

The northern proposed transmission line to south of Las Vegas would cross the Muddy River and parallel the Virgin River. Fish in these rivers include the nongame roundtail chub, swiftwater roundtail chub, mountain sucker, humpback sucker, mosquitofish and shortfin molly, and the endangered or protected Virgin River spinedace, Moapa dace, and woundfin. (The last three species are discussed in the threatened species section.)

The proposed transmission line through southern California would not directly cross any permanent rivers or ponds.

Limestone quarry impact area

Both deer and elk are found on the proposed quarry site. Deer inhabit the area during the winter months; however, the numbers are relatively low. Elk migrate to higher elevations nearby during the winter and move down on reseedings near the quarry site in the early spring to feed and drink from the springs in the area. Cougars (a game animal in Utah) are occasionally present.

Sage grouse are found throughout the valley. One grouse strutting ground is about 4 miles south of the proposed quarry site. The area around Tom Best Spring is very important for brooding. Sage grouse are found throughout the bottom of the valley and along the East Fork of the Sevier River.

The Utah prairie dog, an endangered species, is found throughout the valley. Some colonies are within 1/2 mile of the southern boundary of the proposed quarry area.

Nongame animals in the proposed area include coyotes, bobcats, jackrabbits, eagles, foxes, owls and several other species of small birds and ground-dwelling mammals.

Ecological interrelationships

Kaiparowits Plateau impact area

Introduction

From early days of Utah settlement through the 1940's, the Kaiparowits Plateau area had been heavily grazed by cattle and sheep. Beginning in the 1950's, mineral exploration was conducted throughout the area. The combination of man's activities in livestock grazing and mineral exploration has resulted in numerous roads and four-wheel drive trails crisscrossing the area.

On Horse Flat, pinyon and juniper trees have been removed by chaining, and the areas reseeded to a grass mixture. Lightning has ignited coal deposits and resulting fires have left numerous burned-over areas on Fiftymile Mountain.

Desert bighorn sheep once inhabited Fiftymile Mountain. However, the animal no longer lives in the area, because of three factors which occurred simultaneously: uncontrolled hunting by early settlers, direct competition with domestic sheep for forage, and contraction of fatal diseases from contact with domestic sheep.

To fully understand ecological interrelationships in the Kaiparowits Plateau impact area, the affinity of plant and animal distribution to soils and climate must be recognized. The ecological interrelationships are divided into two segments (Illustrations II-28 and II-29). The first segment pertains to physical relationship, prevailing winds, elevation, average rainfall, frost-free days, potential evapotranspiration, water quality of surface waters (where known) and average flow and sediment load of Wahweap Creek, Warm Creek, and Last Chance Creek. The second segment concerns biological relationships dealing with interaction of soils and vegetation to animal populations and distribution. Living components of any community are also influenced by physical factors, such as wind, exposure, and rainfall.

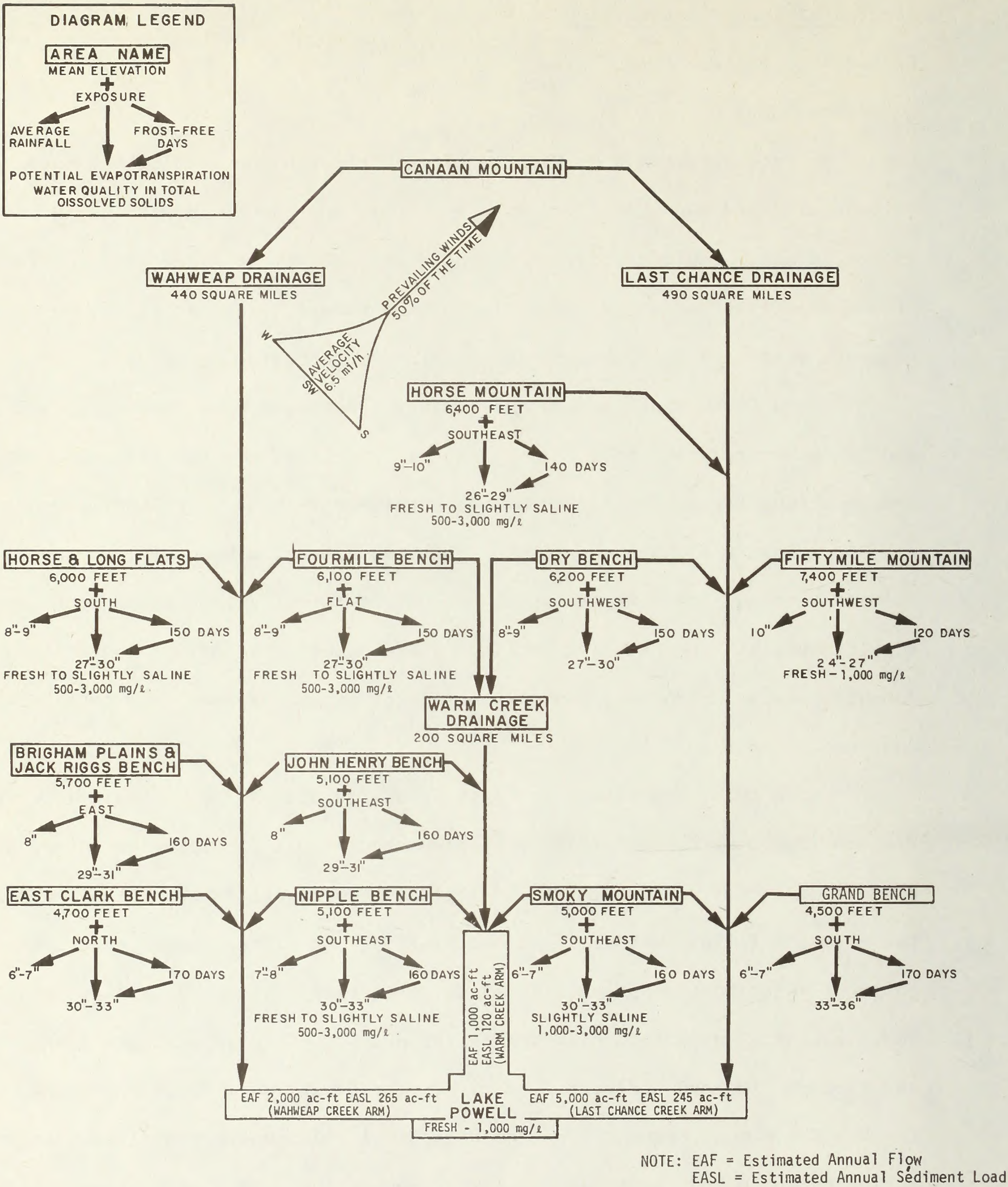


ILLUSTRATION II-28

Schematic of Existing Ecological Interrelationships - Biological Relationships

SCHEMATIC OF EXISTING ECOLOGICAL INTERRELATIONSHIPS
BIOLOGICAL RELATIONSHIPS

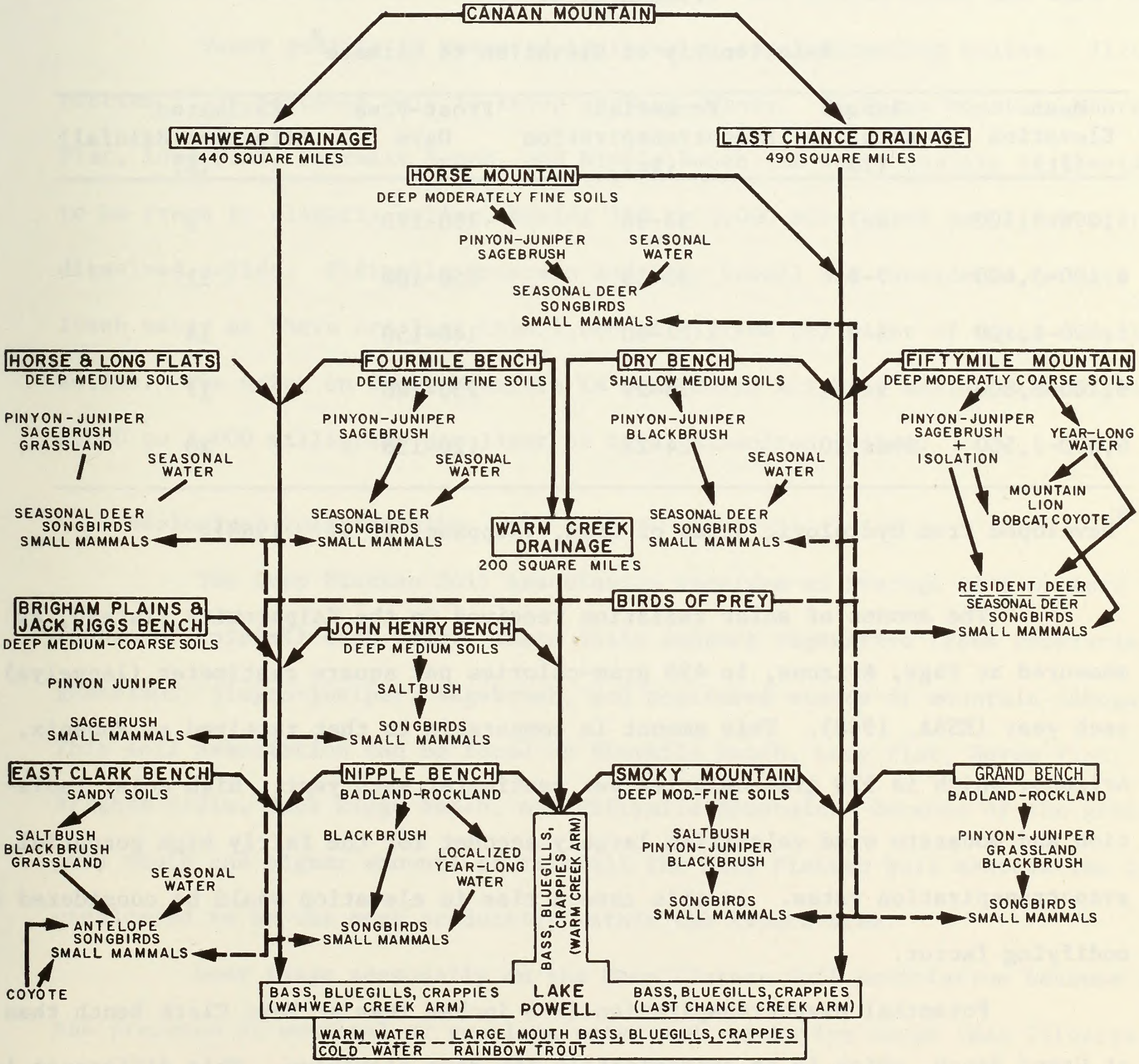


ILLUSTRATION
II-29

Physical relationships

Wind velocities in the impact area average 6 to 8 miles per hour, originating out of the west through the south 50 percent of the time. At other times, winds originate out of the remaining quadrants of the compass at considerably lower velocities.

Figure II-47 depicts general relationship of elevation to annual rainfall, potential evapotranspiration, and frost-free days.

FIGURE II-47

Relationship of Elevation to Climate[a]

Mean Elevation (ft)	Annual Rainfall (in)	Potential Evapotranspiration (in)	Frost-Free Days	Estimated Effective Rainfall (%)
4,000-4,700	6-7	33-36	160-170	8
4,700-5,400	7-8	30-33	150-160	11
5,400-6,100	8-9	27-30	140-150	14
6,100-6,800	9-10	26-29	130-140	17
6,800-7,500	Over 10	24-27	120-130	20

[a] Developed from Hydrologic Atlas of Utah, (Jeppson, et al., 1968)

The amount of solar radiation received on the Kaiparowits Plateau, as measured at Page, Arizona, is 498 gram-calories per square centimeter (langelys) each year (ESSA, 1968). This amount is comparable to that received at Phoenix, Arizona, which is 520 gram-calories per centimeter each year. High solar radiation and moderate wind velocities largely account for the fairly high potential evapotranspiration rates. In this case a rise in elevation would be considered a modifying factor.

Potential evapotranspiration is 3 inches less at East Clark Bench than at Grand Bench, which is at approximately the same elevation. This difference is

due to the north-facing slope of East Clark Bench, which tends to disperse solar radiation over a larger area, whereas Grand Bench has a south-facing slope, which tends to concentrate solar radiation on a smaller area (See Illustration II-28).

The best possible estimates and measurements available indicate that Lake Powell receives approximately 8,000 acre-feet of water and 630 acre-feet of sediment annually from Wahweap, Warm and Last Chance Creeks. Last Chance Creek contributes the most water, followed by Wahweap Creek and Warm Creek. Wahweap Creek contributes the most sediment followed by Last Chance Creek and Warm Creek.

Water quality is measured in terms of total dissolved solids. Illustration II-28 pertains only to known surface waters. On Horse Mountain, Horse Flat, Long Flat, Fourmile Bench, and Nipple Bench the water quality is considered to be fresh to slightly saline, having 500 to 3,000 milligrams per liter of total dissolved solids. Fiftymile Mountain and Lake Powell are considered to have fresh water as there are less than 1,000 milligrams per liter of total dissolved solids. The water on Smoky Mountain is considered slightly saline, containing 1,000 to 3,000 milligrams per liter of total dissolved solids.

Biological relationships

The Deep Plateau Soil Association receives an average of 8 or more inches of rainfall each year. These soils support vegetative types consisting of grassland, pinyon-juniper, sagebrush, and scattered stands of mountain mahogany. This soil association can be found on Fourmile Bench, Long Flat, Horse Flat, Brigham Plain, Jack Riggs Bench, and Fiftymile Mountain. Because of the greater soil depth and higher amounts of rainfall the Deep Plateau Soil Association is considered to be the most productive within the impact area.

Deer range seasonally on the Deep Plateau Soil Association because of the presence of seasonal or yearlong water and vegetative cover (see Illustration II-29). In addition to the seasonal deer, there is also a resident deer herd

on Fiftymile Mountain. The yearlong water on Fiftymile Mountain results from the combination of higher rainfall, lower evapotranspiration than the surrounding area, and coarse soils with relatively low water-holding capacity. Other deer wintering areas receive lesser amounts of rainfall and consequently lack a reliable water supply during dry periods of the year. The resident deer herd on Fiftymile Mountain probably thrives from the combination of remoteness, reduced competition from livestock grazing, and greater amounts of sagebrush and mountain mahogany.

The Shallow Plateau Soil Association receives 6 to 10 inches of rainfall a year. These soils support pinyon-juniper, grassland and blackbrush. Because of shallow soils, plants are not as vigorous or robust as their counterparts in the Deep Plateau Soil Association. The Shallow Plateau Association can be found in the southwest portion of the impact area known as Flat Top, and in the northeast section of the impact area. The northeast area is the only portion of this soil association that supports deer in winter because of the greater amounts of rainfall and seasonal water.

The Sandy Soil Association receives an average of 7 to 8 inches of rainfall each year and supports grassland and shrub vegetative types. This soil association is found on East Clark Bench. Although the Sandy Soil Association receives low amounts of rainfall, most is available for plant growth, making the area as favorable as the Shallow Plateau Soil Association for grass production.

A small antelope herd is found in the vicinity of Shallow Plateau and Sandy Soil Associations in the broad, open areas of saltbrush, blackbrush and grassland. Although rainfall varies from 6 to 10 inches, antelope can survive, as water is provided by springs, ponds, and snow.

The Shallow Soil-Rock Outcrop Association receives some 8 to 9 inches of rainfall annually. These soils support the pinyon-juniper vegetative type. The Shallow Soil-Rock Outcrop Association can be found in the vicinity of Dry

Bench. There is seasonal water in the area that is utilized by wintering deer. However, because of the shallow and rocky soils, the understory within the pinyon-juniper is either poor and lacking in vigor, or nonexistent.

The Badland-Rockland Association receives 6 to 9 inches of rainfall each year. Saltbrush and blackbrush are present except on the saline flats and in those areas that are steep, rocky, or clayey. This association occupies areas on Nipple Bench and Grand Bench where there is very little soil formation and poor drainage.

In general, areas with the most diverse types of vegetal cover also support the greatest number of different species of animal life. For example, Fourmile Bench with Deep Plateau soils and interspersion of pinyon-juniper woodland, sagebrush, shrubs, grasses and forbs supports twice as many species of mammals and four times as many species of birds as does Nipple Bench with Badland-Rockland soils and an open expanse of grass and desert shrub vegetation. Large pinyon-juniper woodlands on higher benches and cottonwood trees on some canyon floors are important to many birds for nesting.

More than any other single variable, climate is the overriding force that molds the biological character of the Kaiparowits area. Precipitation is scant and erratic, summers are hot, and the evaporation rate is high. Steep, rock slopes cause much of the precipitation to run off without becoming available to plants or animals. Consequently, the area is comprised of plants and animals well-adapted for survival in a harsh, arid environment. Even for these well-adapted species, existence is often precarious. Populations of plants and animals fluctuate considerably from year to year in response to climatic variations. When the average moisture pattern is barely sufficient for plant growth, even a slight variation in the amount or seasonal occurrence of precipitation can cause drastic changes. This in turn triggers changes in the population of many species of animal life.

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The portion of total forage actually usable for some animals is controlled by the limited number of springs, seeps, and small streams. Large mammals of the area require water at least some of the time. Some can survive for lengthy periods without water when the weather is cold or, in the case of herbivores, when green, succulent vegetation is plentiful. However, none can survive indefinitely without water. Thus, the few existing sources of water are crucial to populations of deer, antelope, mountain lions, and bighorn sheep. Some extensive areas lacking water can only be used by large mammals during winter when snow provides the needed moisture.

Most birds also require water, but because of their great mobility, they can travel considerable distances to obtain it. For less mobile species - such as gallinaceous game birds, including chukars and Gambel's quail - it is essential that water, food, and cover all occur in relatively close association. On the Kaiparowits Plateau, the range of these birds is limited to a small area along the Paria River.

Predators, including coyotes, bobcats, mountain lions, and birds of prey, inhabit much of the area. The mountain lion may exert some influence on deer, particularly on Fiftymile Mountain where numerous instances of lion predation have been reported. Predation by coyotes and bobcats may be significant to the small transplanted antelope population which is not yet well established in the new environment.

Some of the less productive vegetal-type areas are important hunting grounds for large birds of prey. Although highly productive vegetal areas may support greater numbers of small mammals, the cover of trees and shrubs makes it difficult for large raptors to secure their prey.

The most obvious competition for food among different animal populations is the competition of domestic cattle with deer and antelope. These species can coexist satisfactorily under certain conditions because of differing

food preferences. However, the limited amount of forage available in the impact area causes cattle and big game animals to compete for many of the same range plants.

During fall and spring migration, waterfowl can be found resting in the Last Chance, Warm, and Wahweap arms of Lake Powell, adjacent to the impact area. Nesting habitat for waterfowl is almost nonexistent and is limited to small isolated areas of suitable cover adjacent to water.

Lake Powell, like most large, deep reservoirs and lakes, seasonally becomes stratified into horizontal layers of water of different temperatures. Warm water forms a layer on top (the epilimnion) and colder, more dense water forms a layer beneath it (the hypolimnion). The two well-defined masses of warm and cold water are separated by a transition zone called the thermocline.

Development of thermal stratification, creating reduced oxygen levels below the thermocline, is a significant event in Lake Powell for it determines availability of nutrients and some elements to phytoplankton (small suspended plant life), and consequently, the availability of nutrients to fish and other aquatic life. Seasonal concentrations of nutrients and some elements are greatly influenced by the acidity/alkalinity (pH) balance of the water and the availability of dissolved oxygen. The thermocline controls the distribution of oxygen and therefore may regulate distribution and success of phytoplankton populations. Thermal stratification also influences distribution and species composition of fish populations.

Lake Powell is predominantly a warm water habitat. Warm water fishes, including largemouth bass, crappie, bluegill, and catfish, are found throughout most of the reservoir in the upper, warm stratum. Although experimentally stocked in several areas of the reservoir, trout are largely restricted to one area of deep, cold water within a few miles of the dam, generally at depths of 50 to 100 feet.

Lake Powell currently contains a healthy balance of physical and chemical parameters resulting in a productive and largely self-sustaining sport fishery. For the basic productivity of a body of water to be converted through the food chain into self-sustaining populations of desirable game or food fishes, specialized habitat for spawning and for survival of young of the species are also required. Largemouth bass and black crappie, two of the major gamefish, spawn in water 5 to 15 feet deep.

Lake Powell is a huge reservoir with unique conformation. Much of the shoreline is extremely precipitous, characterized by vertical sandstone walls and steep rocky slopes. A large proportion of the water is 300 feet or more in depth. Area-capacity tables indicate that only 4.5 percent of the total surface area will be ten feet deep or less when the reservoir is completely full. Therefore, major side bays are of particular significance as spawning areas and nursery areas for young fish. Preferred nest sites are in rock rubble at the base of a ledge or large boulders. This type of bottom is common throughout the reservoir, but only in relatively small, localized areas does it occur in combination with suitable water depths.

Wahweap Bay, Warm Creek Bay, and Last Chance Bay on Lake Powell contain significant areas of important spawning habitat. These bays are adjacent to the project impact area, and receive nutrients, pollutants and sediments from it, and are affected by any changes in watershed conditions.

Last Chance Creek drains the largest area, encompassing the west side of Fiftymile Mountain, Squaw Bench, Horse Mountain and the southeast foothills of Canaan Mountain, 12 miles north of the study area. This drainage contributes the largest amount of water to Lake Powell because of its large size, higher amounts of rainfall, and low evapotranspiration rates. However, the Last Chance Drainage ranks only second in the amount of sediment carried into Lake Powell because of the presence of deep soils and dense vegetative cover which impedes erosion.

The smallest drainage area is the Warm Creek Drainage which includes the west side of Smoky Mountain, east side of Nipple Bench and southeast portion of Fourmile Bench. This drainage deposits the least amount of runoff and sediment into Lake Powell, although the soils are fragile, sparsely covered with vegetation and susceptible to high amounts of runoff. The amount of runoff and sediment deposited in Lake Powell from Warm Creek drainage is limited by the size of the drainage.

Wahweap Creek Drainage is slightly smaller (10 percent) than the Last Chance Creek drainage. Included in the Wahweap Creek system are the west side of Nipple Bench, Jack Riggs Bench, the southwest portion and west side of Fourmile Bench, Horse Flat and Long Flat and the southern foothills of Canaan Mountain. This drainage contributes the largest amount of sediment to Lake Powell, because of the fragile soils and sparse vegetative cover at lower elevations. Wahweap Creek Drainage also contributes the second largest amount of runoff.

The many species of insects and other invertebrates found throughout the impact area play significant roles in the biological communities. Many are important food for birds, insects, frogs, toads and other small mammals such as bats. Larger insects, including grasshoppers and beetles, are important food for foxes and coyotes. Some aquatic forms enter Lake Powell and become part of the food chain that supports fish life. Many invertebrates influence vegetation of the terrestrial habitat. Some are essential for pollination of plants. Others, such as ants, consume significant amounts of forage, thus competing with other wildlife. A number of insects inhibit the growth of certain plants by inflicting injury. Invertebrates of the Kaiparowits area are listed in Appendix II-16.

Bacteria and fungi are inconspicuous but important to the growth of terrestrial vegetation and therefore important to the animals that depend on vegetation for food and shelter. Essential soil nutrients such as sulfur and

nitrogen are made available to higher plants through decomposition of organic matter by fungi and bacteria. The number and variety of microorganisms present in a given area is closely related to the depth and moisture-holding capacity of the soil. Surface vegetation, in turn, influences soil depth and moisture-holding capacity by controlling erosion and runoff, and also produces the organic matter on which bacteria and fungi feed.

Transmission system impact area

Along the proposed transmission system impact area, the ecosystems have declined to a lower productivity and biomass, with lower populations and diversities of species and life forms than were present prior to the introduction of livestock. Where undisturbed, the ecosystems have remained relatively stable and have reached a natural equilibrium. All energy coming into the community is used up in either maintenance or leakage.

The lack of permanent water sources and the incident of low rainfall restrict numbers and variety of both plants and animals. Except in the chaparral growth areas in Arizona and California, and in the riparian habitat, plants cover between 5 and 30 percent of the land surface. Food sources are limited and the general biological productivity is low. Most plants and animals which survive in this environment have either the ability to store water, or to tolerate long periods without it.

When the rancher moved into this area, his grazing livestock began utilizing plant energy. Native herbivores were reduced, food chains were shortened, and large numbers of domestic livestock were confined on the land. The yield of livestock products was high at first, but then declined due to changes of the vegetation, soil, microclimate and decomposers. Through range management practices, this deterioration has slowed, and now most grazing exists in a state of equilibrium with plant life.

In areas nearer population centers, urbanization, industry, and outdoor recreational users are changing the natural ecosystems. In all areas, the lack of one of the natural ecological interrelationship components - fire - has permitted the woody species to invade and in some cases outcompete other vegetation types. Fire has been controlled to protect man's harvesting of natural resources and to protect man-made structures.

In the chaparral types and riparian habitat, plants cover 60 percent or more of the land surface. Food sources are plentiful and general biological productivity is higher than in any other vegetative type along the route.

The Kaiparowits to Phoenix transmission line would parallel the existing APS Navajo to Westwing transmission line. Construction of the existing line resulted in removal of pinyon-juniper vegetation along the right-of-way, where the trees would be within 17 feet of the proposed transmission line, or within a tower pad, pulling site, or roads on the plateaus near Williams, Arizona. The Kaiparowits to Eldorado transmission line would parallel the existing Navajo to McCullough transmission line. Construction of the existing Navajo-McCullough line has also resulted in the removal of some pinyon-juniper vegetation along the right-of-way on the Kaiparowits Plateau and Beaver Dam Mountains.

The Kaiparowits-Moenkopi-Mohave transmission line would parallel the existing Moenkopi-Eldorado and Bureau of Reclamation 230 kV transmission line heading east from Mohave. Construction of these transmission lines removed approximately 80 miles of pinyon-juniper woodland along the right-of-way. The Mohave-Serrano transmission line would parallel existing 230 kV and larger transmission lines along approximately two-thirds of its route. The northern Kaiparowits-Mohave preferred alternate would parallel an existing 500 kV line from Eldorado to Mohave.

Construction of these existing routes disturbed desert scrub types, and because of a lack of moisture, recovery has been very slow. These disturbed

areas may never support the microclimate that was present before the transmission lines were constructed. Desert scrub vegetation may recover in 20 to 30 years, but in some areas the erosion pavement may never be the same.

Land which would be traversed by the Arizona Strip preferred alternate has been subjected to heavy livestock grazing, which has resulted in increased pinyon-juniper cover and a decreased grass-forb density. To reverse this vegetational change, pinyon-juniper along 6 miles of the route have been mechanically removed.

Both the Kaiparowits-Phoenix and Mohave-Serrano routes would traverse approximately 90 miles of chaparral. Approximately 70 miles of this type is in western California. The area of chaparral in Arizona is north of Phoenix. Because of climate and soils, the chaparral type provides a dense, diverse, multilevel vegetative cover. Because of plant diversity, a wide variety of animal species inhabit this type.

Where man has disturbed the chaparral type without removing the top soil and plant roots, chaparral vegetation has reestablished the site to its original density within a 5-year period. The overstory trees, however, have taken 15 to 30 years to recover. In general, disturbed areas along the existing transmission routes have been set back to a subclimax vegetation stand. This alteration of the flora has caused a displacement and alteration of the fauna.

Limestone quarry impact area

In early days of settlement, several homesteads were developed in Johns Valley. Farms were established in the lower part of the valley and the land subsequently plowed and cropped. These old homesteads have since been abandoned, resulting in invasion of rabbitbrush on formerly cultivated fields. The fields now provide pastures for livestock.

In recent years the Sevier River was dammed at the headwaters for irrigative purposes. This dried up the East Fork drainage through Johns Valley. Because of this drying-up of the drainage, areas that were formerly wet meadow and willow bottoms now support a vegetative cover of grasses and shrubs. Areas that were overgrazed in earlier times are now under strict livestock management. Large areas of sagebrush have been killed by herbicides, and the native pinyon-juniper vegetation has been removed by chaining from several hundred acres. These areas, formerly vegetated by shrubs and trees, have been reseeded to grass species.

Water quality in the immediate area is fresh and of high quality for irrigative and domestic purposes. At present, water in the Sevier River system is fully appropriated. New applications for withdrawal of surface water would conflict with existing water rights. This same conflict would also occur if new applications were made for ground water. Permits to do so are restricted within the Sevier River system.

Because of its high elevation (7,400 to 7,800 feet), the proposed limestone quarry area receives an annual precipitation of 12 to 16 inches. There are only 80 frost-free days, and the potential for evapotranspiration is 18 to 21 inches (Jeppson, et al., 1968).

Prior to settlement, Johns Valley supported wildlife which included antelope, mule deer, desert bighorn, sage grouse, forest grouse, birds of prey, rodents and other small mammals. With the change in vegetative types, due to farming and direct competition by domestic livestock, the antelope and desert bighorn were virtually eliminated and the mule deer and sage grouse greatly reduced in numbers. Since the end of farming and the beginning of range improvement practices, the habitat of Johns Valley area is slowly improving. Sage grouse, mule deer, and elk are again found in some areas, and the potential exists for reintroduction of antelope and bighorn.

Man directly affects the predator-prey relationship, as he hunts cougar, coyotes, and bobcats that inhabit the area. Cougar and coyotes have remained at a stable population level, whereas, bobcat populations have been reduced by increased harvests brought about by the high price of fur.

Paleontology, archaeology, and history

Kaiparowits Plateau impact area

Paleontology

Information in this section is based on literature of the Department of Geology at the Museum of Northern Arizona, including records of limited field investigations, and fossils collected by the museum.

Eight fossil sites have been found on Fourmile Bench. Six of these are in the Kaiparowits Formation and two in the underlying Wahweap sandstone. Two sites exhibit dinosaur bones, fragments of turtle shells, reptile teeth, fish scales, and three species of gastropods. Small fragments of fossil bone and fish scales were found in coarse sandstone or gravel at three other sites. Exposures of this gravel occur over a large part of the proposed generating facility site, and represent the lower part of the Kaiparowits Formation (Marshall, Breed, 1974).

Two fossil wood sites (one in the Kaiparowits Formation and the other in the Wahweap sandstone) provide limited scientific data since there is an abundance of similar resources in other localities. A large leaf similar to a palm was found in the Wahweap sandstone (Marshall, Breed, 1974).

Coal in the area contains an assortment of plant impressions. The impressions are not of high scientific value because they are similar to abundant fossil remains in other localities.

To summarize, fossil vertebrates are relatively abundant within the Kaiparowits Formation, with only sparsely fossiliferous remains occurring in the Wahweap sandstone. Fossils and their interpretation provide evidence relating to species evolution, migration, range, succession and inter-species competition. Paleontological resources assist in interpretation of the geologic past and lead to an understanding of present life and environmental conditions. Such study will help predict the course of future developments.

No discussion can be made of paleontological values associated with the proposed townsite and highway system because studies are incomplete.

Archaeology

A secondary influence zone encompassing an area slightly larger than the Kaiparowits Plateau impact area was developed for purposes of archaeological investigations (Illustration II-30).

Non-Indian history

Earliest white exploration of the area was in 1776 by the Franciscan fathers, Dominguez and Escalante. The Franciscan party, seeking a practical route and trade tie between New Mexico and California, also hoped to establish intermediate mission posts. Another less documented journey was the Antonio Armijo party in 1829. Other explorations in the general area were conducted by Sitgreaves in 1851, Ives from 1857 to 1858, MaComb in 1859, and John W. Powell in 1869. Explorations by Mormon scouts, looking for arable lands, were made between 1850 and 1870.

Two settlements, Paria and Adairville, were founded along the Paria River, within the secondary influence zone. Paria, officially founded in 1870, began as the small farm of Peter Shurtz and his family in 1865. The period of time of occupation at Paria is uncertain. One source claims the small town was occupied from 1874 to 1890, with a maximum population of 100 (Abbey, 1971). Frequent floodings, alkaline soil, and mineralized water made long-term agriculture in Paria a hopeless venture, and the town was abandoned before 1900. Log buildings remain today as evidence of the hapless town. The town of Adairville was founded in 1873. Little information is available, and little physical evidence of the town site remains.

During the late 1800s, gold mining was a major activity in the area. The second Powell expedition discovered gold in 1871 near the Crossing of the

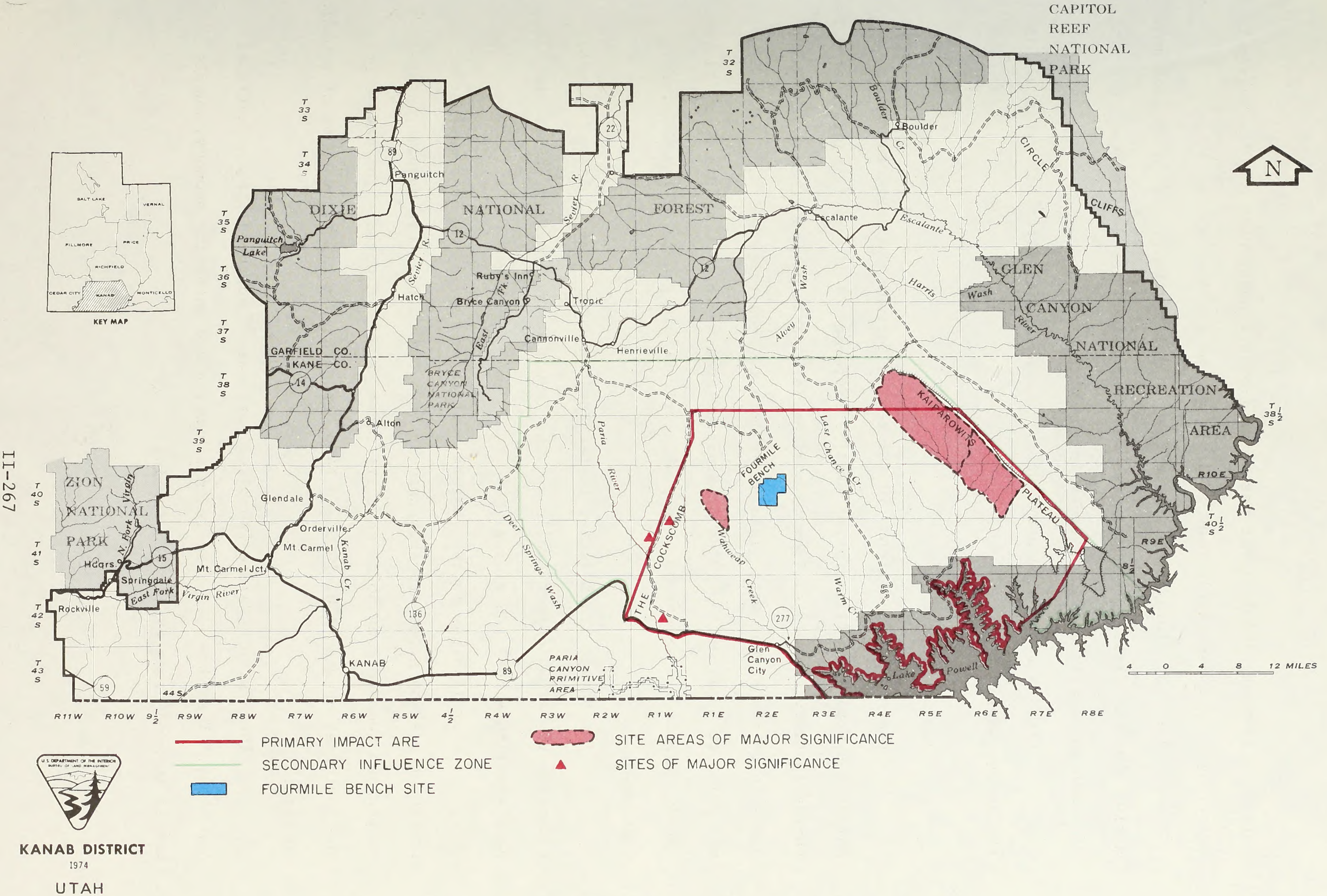


ILLUSTRATION II-30

Areas of Archaeological Importance

Fathers (Crampton, 1960). Gold was found from the upper part of Glen Canyon to Lees Ferry. A 10-year gold boom followed on the San Juan River.

A second mining boom in the Glen Canyon region proved to be much more active than the first. The gold rush was responsible for development of a number of roads and trails including those in the Warm Creek area.

Studies document approximately 35 non-Indian historical sites within the impact area.

Indian history

Historic Indian groups in the region include the Southern Paiute, Navajo and Hopi (see Illustration II-31). Evidence of the Hopi consists of a few sherds (pottery fragments) from camp sites in Kane Wash, Last Chance Creek and one site on the Kaiparowits Plateau. Pueblo IV Jeddito types (A.D. 1300-1500) may point to Hopi hunting trips originating from south of Cummings Mesa (Lister, 1964). Hopi roots extend back to prehistoric Pueblo groups of the Colorado Plateau.

The Navajo Trail (refer to Recreational resources, Cultural values) traverses the area. Other trails are the result of such activities as the Black Hawk War (1865-1868) and mining.

Over 15 sites in the eastern portion of the impact area mark stock trails or grazing areas probably used by Navajo Indians. Log dugways on steep slopes and toe and hand holds up cliff faces have been noted. The Navajo entered the Southwest between A.D. 1300 and 1400, or perhaps earlier, as bands of nomadic hunters.

The Southern Paiute inhabited portions of southern Utah as early as A.D. 1100. They depended chiefly on a hunting and gathering economy, supplemented in some areas by limited farming.

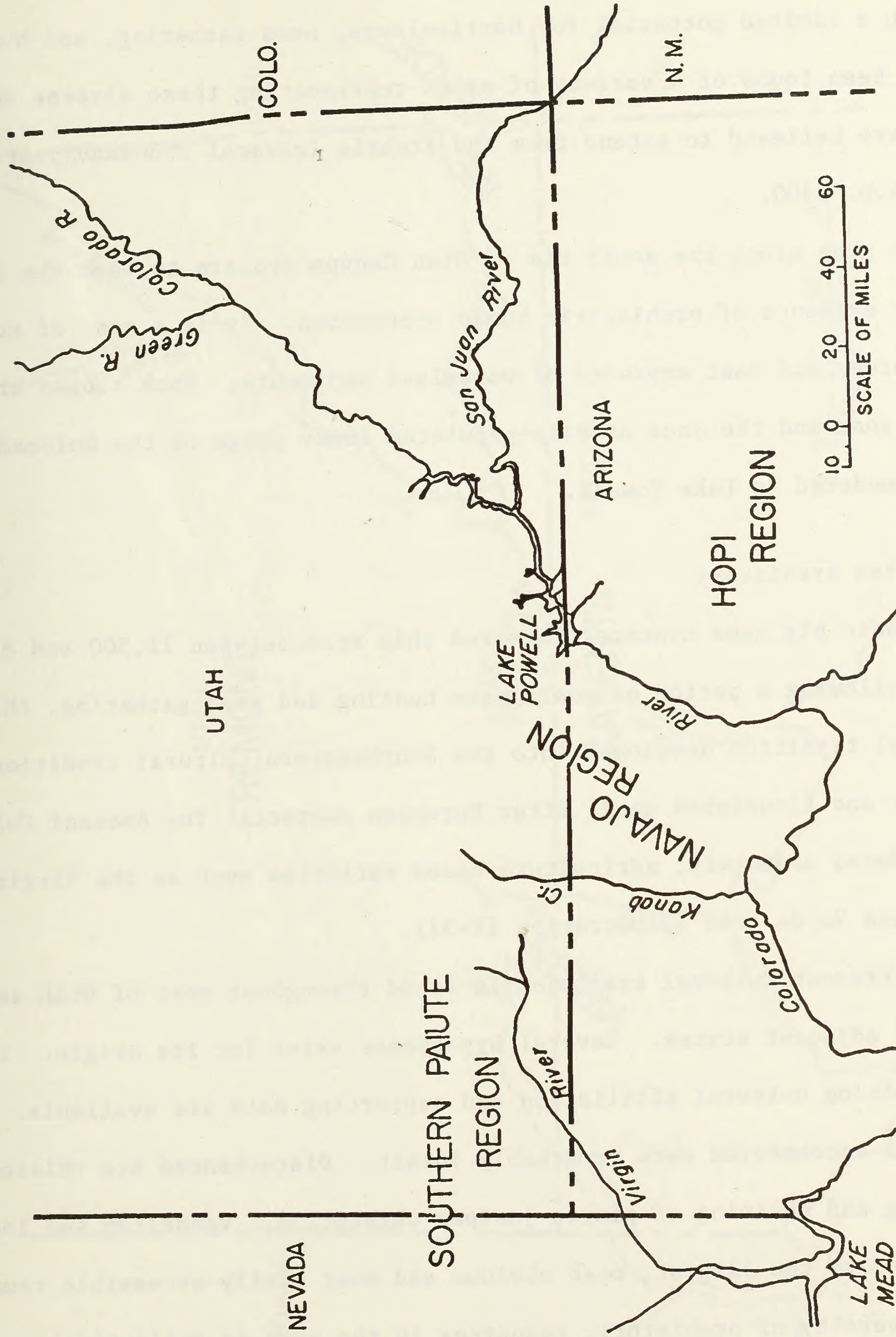


ILLUSTRATION II-31

Ethnic Groups in Impact Area and Influence Zones

Aerial studies of the impact area revealed some surface water even during the driest season prior to summer rains. These water areas are sparse, however, with a limited potential for horticulture, seed gathering, and hunting. Evidence has been found of a variety of sites representing these diverse adaptations which are believed to extend from the Archaic (several thousand years ago) to at least A.D. 1300.

The area along the south rim of Glen Canyon appears to have the least potential for evidence of prehistoric human occupation. It is a zone of scanty natural resources and vast expanses of wasteland sediments. Rock slopes bridge the highland zone and the once heavily-populated inner gorge of the Colorado River, now inundated by Lake Powell.

Indian prehistory

Nomadic big game hunters traversed this area between 11,500 and 8,000 years ago. Following a period of small game hunting and seed gathering, the Desert Cultural tradition developed into the Southwestern Cultural tradition about 100 B.C. and flourished until after European contact. The Anasazi Cultural tradition produced sedentary, agriculture-based varieties such as the Virgin, Kayenta and Mesa Verde (see Illustration II-32).

The Fremont Cultural tradition is found throughout most of Utah as well as portions of adjacent states. Several hypotheses exist for its origin. Inventories outlining cultural affiliation and supporting data are available.

Sites encountered were remarkably intact. Disturbances are related to cattle ranching and chaining of pinyon-juniper vegetation. Vandalism and looting seems restricted to the largest, most obvious and most easily-accessible remains.

A diversity of prehistoric resources in the area is reflected by variation in site types, distribution, and cultural affiliations. Only two survey efforts

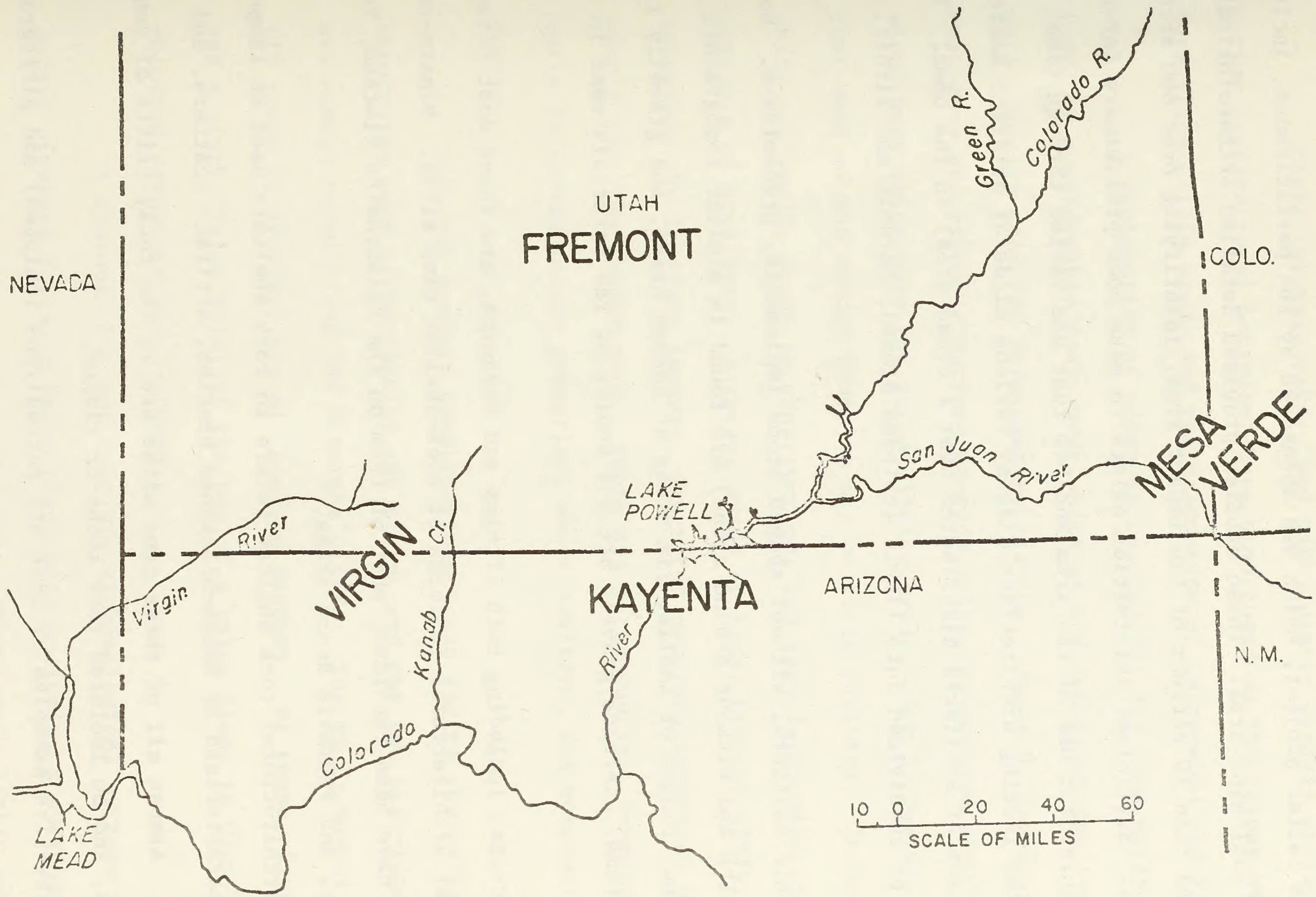


ILLUSTRATION II-32

Prehistoric Cultural Traditions in Impact Area and Influence Zones

of major proportions have been completed in the impact area - the National Park Service Glen Canyon Reservoir Salvage Project and the Nipple-Fourmile Bench Project. The latter project, which was sponsored by the participants, included the proposed coal mine area. These studies provided detailed archaeological survey of less than 10 percent of the impact area, identifying over 600 archaeological sites. Sufficient information exists to make some preliminary inferences about the prehistoric use of the area and how that use varied through time.

Sites lacking architecture, display various kinds of artifact scatters (a concentration of artifacts distributed over a broad area) in the open. These scatters can be subdivided into lithic (chipped stone), ceramic and lithic, and ceramic.

Lithic scatters, without shaped stone implements, predominate. However both types (with and without ground stone) are found in similar topographic situations-sandy ridges or knolls, rim areas at canyon heads, and gravelly terraces in canyon bottoms. Terrace gravels are one source of raw materials used in tool manufacture.

Scatters, including both lithics and ceramics, are found most often in the vicinity of architectural features or rock-shelter camp sites. Ninety-one such scatters have been recorded, most of them on the Kaiparowits Plateau, Vermillion Cliffs, and Fourmile Bench areas.

Nonarchitectural rock shelter refers to rock shelters used as temporary camp sites, characterized by smoke-blackened hearths, artifact scatters, and refuse debris. Almost all of these camp sites are in the rocky cliffs of canyons, on canyon rims, and on isolated rock knobs or ridges.

Twenty-five examples of rock art petroglyphs (chipped) and pictographs (painted) have been noted in the impact area. Largest numbers were found along

Rock Creek and Paria Canyon. Several are associated with architecture or overhangs; the remainder are on canyon cliff faces.

Cists (storage pits), and particularly granary storage structures indicating horticultural activity, have been found on the Kaiparowits Plateau, the Vermillion Cliffs area, and the headwaters of Cottonwood and Paria creeks.

A designation of sites as residential has been deliberately avoided. There is considerable doubt over which of the countless small-room structures were actually used for permanent habitation. Jesse D. Jennings (1966) argues that many are probable surface storage units, associated with undiscovered pit structures which were the actual living areas. Don D. Fowler (1963) suggests that many of the cruder examples may be field shelters. In any case, many of the units are small, crude in construction, and associated with only light surface scatters of artifacts. A recent study by LaMar Lindsay (1974), of importance in assessing the indirect impacts, describes numerous important finds distributed widely over the impact area. These are large pueblos, numerous small masonry units including intact granaries, sherd scatters, and concentrations of lithic debris.

Coursed masonry constructions found during the survey far outnumber structures made of vertically set slabs, and the few slab-lined structures known are concentrated along the Straight Cliffs. The small number of occupation sites (10 rooms or greater) are all coursed masonry. Of these, five were on ridge tops and a sixth (Talus Ruin) at the top of a talus slope in Glen Canyon. The largest recorded structure had 14 rooms.

A thorough but not complete archaeological surface survey of the entire proposed Fourmile Bench plant site including a surrounding 1/2 mile wide strip, has located six types of sites. These are: lithic scatter sites, ceramic scatter sites, lithic-ceramic scatter sites, lithic camp sites, rock shelter-habitation sites, and masonry sites. A total of 30 sites were recorded on the

proposed plant site. Another 20 sites were recorded outside the site boundary, but within a 1/2 mile buffer zone (see Illustration II-33). See Appendix II-25 for additional site descriptions (Fish 1974).

In the proposed coal mine area, 26 archaeological sites were identified. An additional 17 sites were in areas adjacent to the proposed coal mine. These sites fall into five general classes: lithic scatter sites, lithic-ceramic scatter sites, lithic camp sites, rock shelter sites, and historic sites (see Illustration II-34). See Appendix II-25 for additional site descriptions.

Chipped stone artifacts comprise a major portion of the archaeological sites in the area and represent the material expression of a wide variety of prehistoric human activity. Included in the lithic inventory are the waste flakes or by-products of core preparation, the tool itself, and modifications of the tool during its lifetime, through utilization and reworking. Lithic artifacts are preserved in remarkable abundance. Their nature required frequent replacement as they wore out, were broken, or were lost.

Most lithic items represent prehistoric garbage, going unnoticed after their creation or use. Thus, these items may be regarded as having in-place quality when found in an undisturbed area. Careful excavation of lithic sites can, therefore, shed light on patterns of human activity at a given location.

Lithic sites constitute an easily disturbed resource. Minimal activity, such as casual surface collection, vehicular travel, or heavy foot traffic can significantly lessen the scientific value of the site.

Two major categories of sites can be distinguished on the basis of lithic remains - specialized sites and habitation sites. Specialized sites are those where remains are the products of specialized and transitory human activities. Sites with concentrations of raw material, such as chalcedony nodules, cobbles, or other chipping materials, reflect initial steps in lithic manufacture.

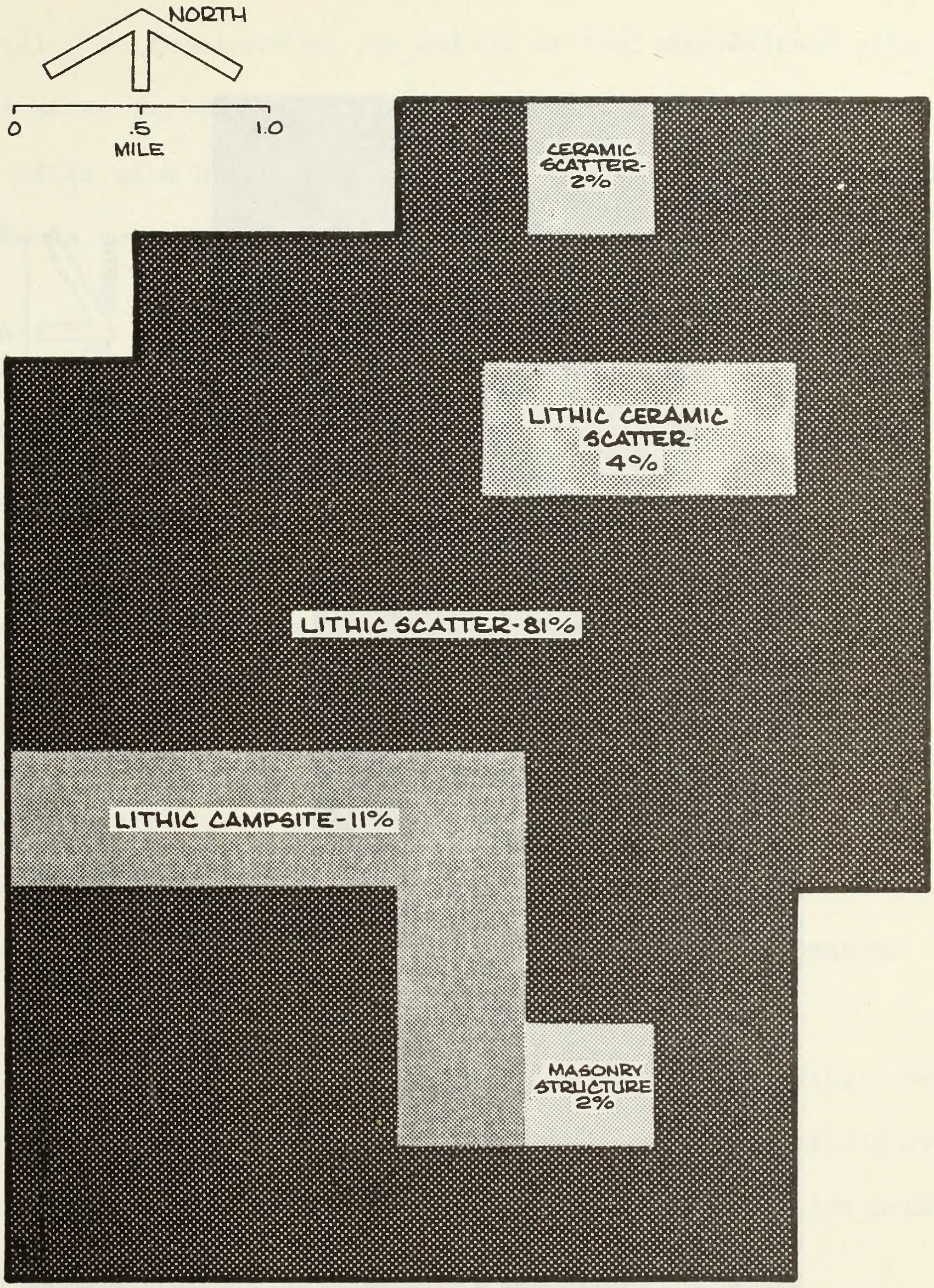


ILLUSTRATION II-33

Distribution of Archaeological Site Types
Fourmile Bench Plant Site

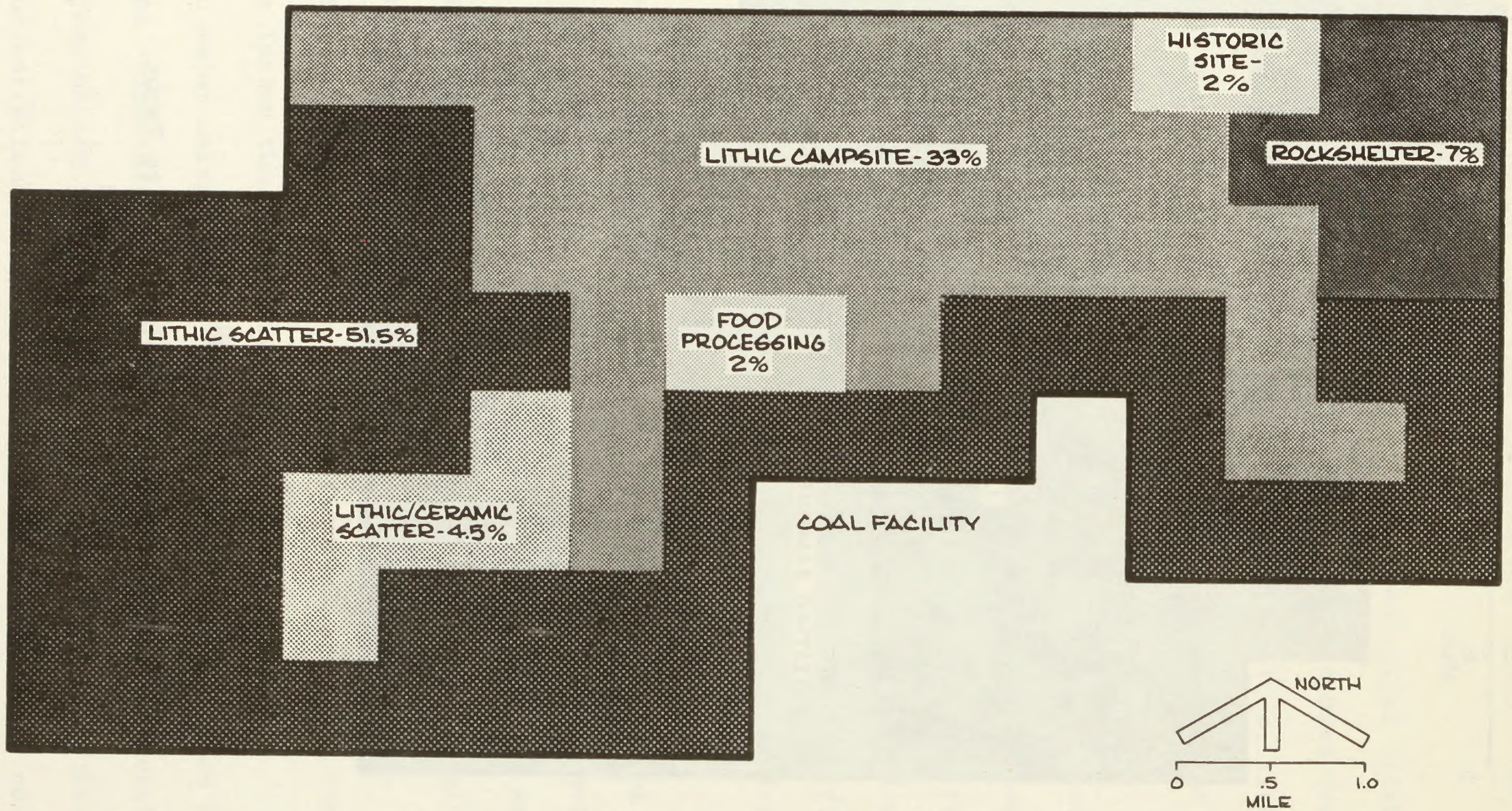


ILLUSTRATION II-34

Distribution of Archaeoligical Site Types in Coal Mine Facility Area

Numerous secondary chipping sites were found, representing further preparation of lithic material. At these sites, the debris of tool manufacture attests to production of stone implements carried elsewhere for use. Scattered throughout the area are sites with high proportions of a few tool types. Limited and specialized tools concentrated in these sites reflect use and manufacturing activities.

Habitation sites are those with a much broader range of tool types and debris. Long use of the site resulted in a mixture of materials from a large variety of activities.

The single masonry storage unit found on the proposed plant site suggests the likelihood of similar units elsewhere in the impact area. Similar structures are known to have been built and used by hunters and gatherers for the storage of plant products. The recording and study of natural and domestic plants is critical to the understanding of food-gathering activities.

Because initial studies are incomplete, no discussion can be presented of values associated with the proposed town site and highway system. Archaeological site photos are included as Appendix II-26.

Consultation with the Utah Historic Preservation Officer revealed no known National Register properties in the impact area. Criteria required by the Historic Preservation Act of 1966 (Section 106) and Executive Order 11593 of 1971 (Section 2/b) are presented in Chapter III.

Transmission system impact area

Paleontology

Introduction

Fossiliferous geologic formations crossed by the proposed routes in Utah, Arizona, and Nevada are presented in summary form in Figure II-48. These formations range in geologic age from Cambrian to Cretaceous, and occur

FIGURE II-48

Fossiliferous Geologic Formations - Mesozoic Rocks

Formation	Environment of Deposition	Age	Fossils Present
Kaiparowits	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other reptiles, fish, mollusks, gastropods, wood, plant remains
Wahweap	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other reptiles, fish, freshwater gastropods, ostracods, pelecypods
Straight Cliffs	Fluvial, Near-shore, Marine	Upper Cretaceous	Vertebrate remains, marine invertebrates, wood, plant remains
Tropic	Marine	Upper Cretaceous	Marine invertebrates
Dakota	Flood Plain, Fluvial Lacustrine, Near-shore, Marine	Upper Cretaceous	Dinosaur and other reptiles, fresh-water invertebrates, plant remains
Entrada	Aeolian	Jurassic	Dinosaur tracks
Carmel	Nearshore Marine, Marginal Terrestrial	Jurassic	Marine invertebrates
Navajo Sandstone	Aeolian	Triassic, Jurassic	Dinosaurs, dinosaur tracks, plant remains, ostracods
Kayenta Sandstone	Fluvial	Triassic	Dinosaur and other reptiles, dinosaur tracks
Wingate	Aeolian	Triassic	Reptiles, fish

(Continued)

FIGURE II-48 (Concluded)

Formation	Environment of Deposition	Age	Fossils Present
Chinle	Fluvial	Triassic	Dinosaur and other worm trails, anthropods, reptiles, fresh-water mollusks, petrified wood, plant remains, amphibians, fish, ostracods, branchiopods
Moenkopi	Fluvial in east Fluvial, marine to west	Triassic Triassic	Reptile tracks, mollusks, amphibians, fish mollusks (ammonites, snails, clams and nautiloids)
Kaibab Limestone Toroweap Fm.	Marine	Permian	Fish, mollusks, bryozoan, sponges, trilobites, corals, worms, crinoids, echinoids, algae
Coconino Sandstone	Aeolian	Permian	Reptile tracks, invertebrate tracks
Hermit Shale	Fluvial	Permian	Insects, plant remains
Supai Fm.	Fluvial, marine	Permian-Pennsylvanian	Plant remains, amphibian and reptile tracks, mollusks to the west
Redwall Limestone	Marine	Mississippian	Mollusks, corals, trilobites, crinoids, bryozoans, blastoids, foraminifers, fish, ostracods

principally in the Plateau Province, with outlying extensions into the Basin and Range Province (See Topography and Geology, Chapter II). Information for these portions of the transmission system are from Marshall and Breed (1974).

Kaiparowits to Phoenix

Along the proposed routes in Utah and Arizona, areas of known paleontological values include the Echo Cliffs and Badlands from the Gap (Hamblin Wash) to the Moenkopi substation. The Chinle Formation (Triassic) is exposed through much of this area and is paleontologically very sensitive. This formation is known to have fossils of ostracods, brachiopods, mollusks, arthropods, fish, amphibians, reptiles, worm trails, dinosaur tracks, plant remains, and petrified wood. Another sensitive area is near Simmons.

Kaiparowits to Navajo

This proposed Kaiparowits to Navajo intertie is the same as the first 42 miles of the proposed Kaiparowits to Phoenix route, with the same potential impact on paleontological resources of the Chinle Formation. No paleontological values are known in the final 5 miles of this route.

Kaiparowits to Eldorado

After leaving Fourmile Bench, the proposed route would cross nearly the full range of Mesozoic Formations (Figure II-48) where it leaves the "Cockscomb" monocline. From the Cockscomb westward, the proposed route would cross the Moenkopi Formation (Triassic) and the Kaibab Formation (Permian). These formations contain fossils of algae, sponges, bryozoans, corals, echinoids, crinoids, trilobites, mollusks, worms, and fish. There are short distance exposures of older rocks of the Toroweap (Permian), Coconino (Permian), Supai (Permian-Pennsylvania), and Redwall (Mississippian) formations at the Hurricane Faults, which

contains fossils of algae, ostracods, sponges, foraminifers, blastoids, bryozoans, corals, echinoids, crinoids, trilobites, mollusks, worms, fish, invertebrate bracks, amphibian tracks, reptile tracks, and plant remains.

Kaiparowits to Meonkopi to Mohave

The first 113 miles of the proposed Kaiparowits-Moenkopi-Mohave route is as described for the same portion of the proposed Kaiparowits to Phoenix route. Beginning at the Moenkopi switching station, the proposed route crosses large areas of sedimentary rock with both known and undetermined paleontological values. Near the Moenkopi station, the proposed route crosses about 5 miles of red sandstone deposited as marine sediments during the Mesozoic Era. Armored amphibians and crocodile-like reptiles have been found in the Chinle Formation (Triassic); the Meonkopi Formation (Triassic) near Cameron has produced skeletons of dinosaurs and of the most primitive known crocodiles.

Where the proposed route crosses the Coconino Plateau, surface geology consists mainly of Kaibab limestone (Permian) in which typical fossils are likely to include sponges, corals, trilobites, brachiopods, and mollusks.

Mohave to Serrano

The proposed Mohave to Serrano route has the finest paleontological values of the entire transmission system area. The lines cross deposits containing remarkable fossil records from the Tertiary and Quaternary periods, with Mesozoic deposits near the end of the route. (Information for the California Desert portions of the transmission system is from Reynolds, 1974.)

The California Desert is known to contain some of the most important deposits in America. Most of the important deposits contain vertebrates dating from early Miocene to Pleistocene. Recent fossil discoveries, however, indicate that the desert contains Tertiary vertebrate remains which represent almost every

epoch back through Paleocene. In addition, there are extensive invertebrate and floral fossil deposits in many of the vertebrate localities.

The proposed route passes through the Bannock area at the southern end of the Piute Valley, where it enters Ward Valley. Quaternary and undivided Tertiary nonmarine sediments occur along a 4-to-5 mile stretch in this area. The Quaternary deposits consist of older alluvium and local terrace deposits, and may be too coarse for the preservation of fossils. The Tertiary (Miocene) sediments, however, represent a wide range of fossiliferous sediments of the Barstovian Land Mammal Age.

Lake deposits ideal for preservation of fossils are found along the proposed route as it passes through the Mecca and Indio Hills.

In the San Timoteo Badlands, the proposed route passes through 6 miles of prolific fossiliferous sediments on a section between Idyl wild Road (south of Banning) and Gilman Spring Road (San Jacinto Valley). These deposits contain abundant and diverse large and small mammals of Hemphillian, Blancan and Irvingtonian Land Mammal ages (mid-Pliocene to mid-Pleistocene). In addition to the vertebrate fossils, there is also an abundance of fossil mollusks and plants.

At the Terra Cotta Hills, Paleocene sediments occur along the proposed route north of the town of Elsinore. These sediments occur for about 1 mile along the right-of-way and contain a unique group of fossil plants. Savage and Downs (1954) state that "the flora near Elsinore is the earliest record of Cenozoic land life now known in southern California." Remains of associated vertebrate fossils are likely to be found in this area.

Paleontology is well documented for the proposed route, which crosses the Santa Ana Mountains and ends at the Serrano substation in the Peralta Hills. From east to west for approximately 17 miles, the proposed route crosses fossiliferous sediments of the Jurassic, Cretaceous, Paleocene, Eocene, Oligocene and Miocene ages.

Northern Kaiparowits to Mohave preferred alternate

This northern preferred alternate route is identical to the proposed Kaiparowits to Eldorado route, with the addition of 70 miles from the Eldorado substation to the Mohave plant. Here, the proposed route passes along the alluvial Eldorado and Piute valleys, where there is little likelihood of fossil preservation.

Arizona Strip preferred alternate

In terms of the geologic formations crossed, this proposal is essentially the same as the Kaiparowits to Eldorado and Northern Kaiparowits to Mohave routes. Paleontological values should be found similar to those of the more northern section, which lies generally less than 20 miles from, and more or less parallel to, the Arizona Strip route.

Archaeology

Introduction

Intensive inventories have not been made on all archaeological sites within the proposed transmission corridors. Partial surveys, using various sampling strategies, have been done in some areas. The remainder of the information on known archaeological sites is the result of studies not connected with this project. Notations on Illustration II-35 are of known sites where at least some survey work has been done. Lack of notation, therefore, does not necessarily mean the absence of sites-only that survey work has not been performed.

The location of known sites is not revealed, in order to protect the sites from vandalism, looting, and possible damage by well-intentioned visitors.

Since most of the proposed transmission corridors have not been surveyed, "probability models" have been developed to predict which areas along the proposed routes probably have high archaeological sensitivity. These models are based on known site distribution, and on related cultural and environmental-ecological variables (Fish, 1974).

Kaiparowits to Phoenix

Major concentrations of known archaeological sites are in the southern portion of Kaibab National Forest, the northeastern and southeastern portions of Prescott National Forest, and the Bureau of Land Management (BLM) Black Canyon Planning Unit. These areas are in the southernmost third of the route, between where the proposed route crosses U.S. Route 66 and the Westwing station. Illustration II-35 shows these locations.

Perry Mesa Archaeological District, which has been nominated to the National Register, contains a large and important concentration of prehistoric ruins. The danger of disturbance to archaeological sites in this area is very great. Calderwood Butte Archaeological District, also nominated to the National Register, is partly on the proposed route. Another nomination, New River Dams Archaeological District, is within about a mile of the proposed route.

There are at least 28 additional areas of high-to-medium archaeological sensitivity along the proposed route (Hession and Frampton 1974). Figure II-49 identifies these areas of probable sensitivity by square mile area and by link. Illustration II-35 partially reflects locations.

Kaiparowits to Navajo

The first 42 miles of the Kaiparowits to Phoenix proposal are the same as the Kaiparowits-Navajo proposed route. Archaeological values may exist on the final 5 miles of the route, where it would cross Antelope Creek near the Navajo plant.

Kaiparowits to Eldorado

The proposed Kaiparowits to Eldorado line parallels an existing Los Angeles Department of Water and Power transmission line, with a proposed separation ranging from as little as 100 to as much as 2,000 feet. Therefore, results of archaeological studies for the existing line can be applied in some measure to

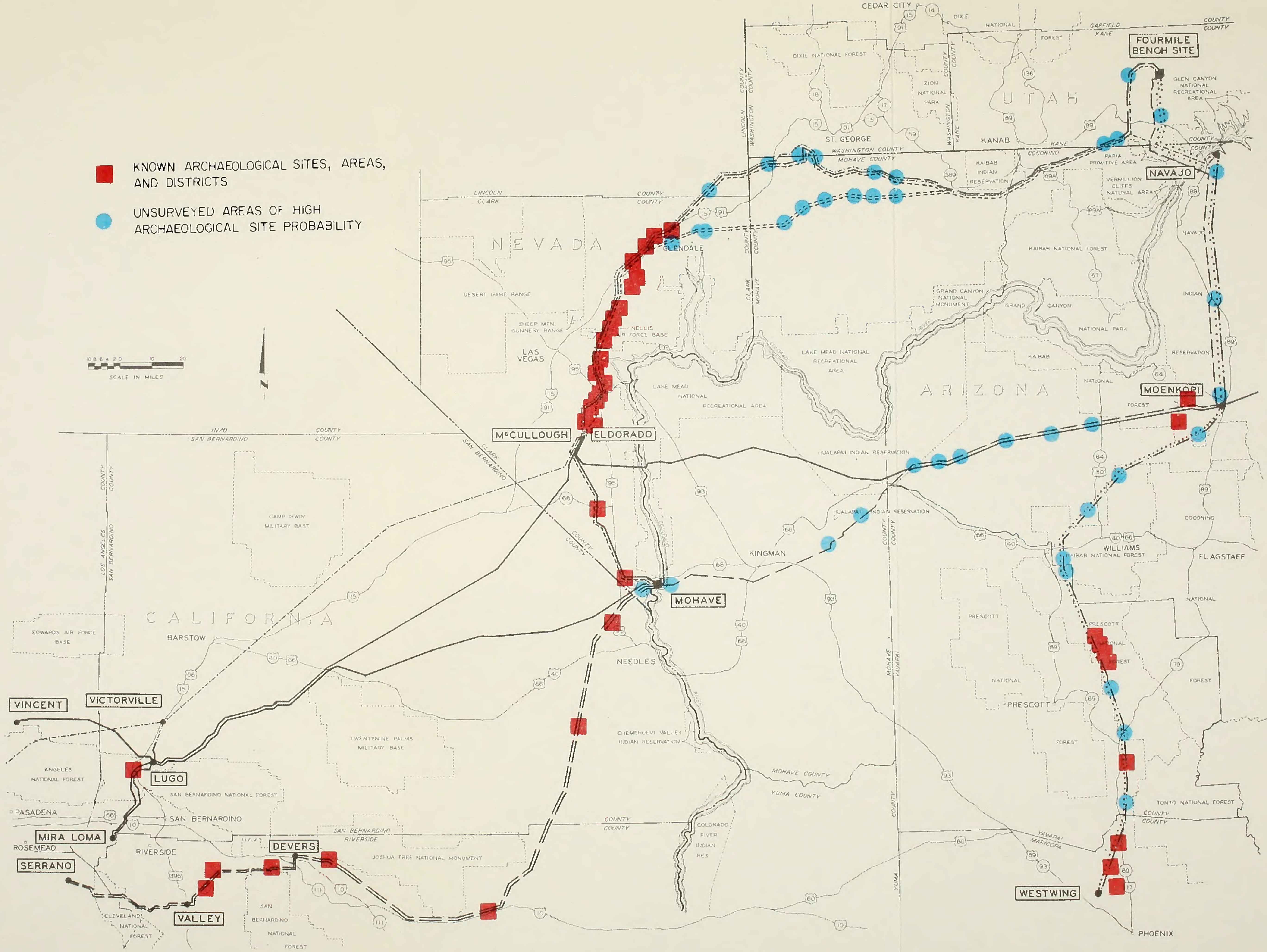


ILLUSTRATION II-35

Archaeological Sensitivity

FIGURE II-49

Kaiparowits to Phoenix
Archaeological Sensitivity

Link[a]	High Sensitivity Square Mile	Moderate Sensitivity Square Mile	Low Sensitivity Square Mile
01	24.0	33.8	23.0
03	2.0	8.6	30.0
08	-	15.4	30.0
11	-	23.4	-
13	-	40.2	-
15	1.2	61.8	-
19	4.0	25.6	-
20	11.0	47.2	-
22	-	13.8	-
24	12.0	36.8	18.0
28	-	31.8	-
29	8.4	1.0	-
32	23.2	4.0	-
33	16.0	5.0	-
34	-	27.4	-
39	0.5	9.0	-
48	0.2	22.8	-

[a]Link numbers refer to a superseded system used at the time of the archaeological study to designate portions of Arizona Public Service alternate transmission line routes. Area figures pertain to a two-mile wide study corridor. Links enumerated apply only to the porposed route.

the proposed route. The 55 archaeological sites identified on the existing right-of-way range from small lithic scatters and rock shelters to a site with stratified, open deposits and eight stone wickiup foundations. Sixteen sites yielded ceramics. No large, permanent settlements were encountered, although possibilities for sedentary occupations exist in such areas as the Paria and Virgin River drainages. Artifact classifications indicate a time range from early Desert Culture to historic Paiute. Ceramic affiliations were predominately with Virgin Anasazi and Paiute, often in a single site.

The Utah and Arizona portions of the proposed route were subjected to a sensitivity ranking (Fish, 1974) which evaluated 77 two-mile square segments between Fourmile Bench and the Arizona-Nevada line (Figure II-50). It was predicted that 51 segments should have moderate, and 8 should have high sensitivity, on the basis of presence of environmental factors which influence human utilization. The term "sensitivity" is roughly equivalent to "expected site density".

Where the proposed line would pass through Nevada, University of Nevada archaeologists examined representative portions of the corridor (Brooks, Larson, and Compton, 1974), locating 30 sites. These include nine rockshelters, two hearths, 14 lithic scatters, four pit houses, and two quarry sites. Additionally, 24 previously-recorded sites in the Las Vegas Wash portion of the corridor were revisited. None of these sites has yet been nominated to the National Register of Historic Places.

Kaiparowits to Moenkopi to Mohave

The first 113 miles of this proposed route are the same as the corresponding section of the Kaiparowits to Phoenix proposal. From Moenkopi substation to a point about midway to the Mohave plant, the proposed line parallels an existing Southern California Edison (SCE) line, previously studied by Museum of Northern Arizona archaeologists. On the basis of their data plus field checks of the

FIGURE II-50

Kaiparowits to Eldorado
Arcaeological Sensitivity

Segment	Rank	Segment	Rank
1	low	42	moderate
2	moderate	43	moderate
3	moderate	44	moderate
4	low	45	moderate
5	moderate	46	moderate
6	high	47	moderate
7	moderate	48	moderate
8	moderate	49	high
9	moderate	50	high
10	moderate	51	moderate
11	high	52	moderate
12	low	53	moderate
13	low	54	high
14	moderate	55	moderate
15	low	56	low
16	moderate	57	moderate
17	moderate	58	moderate
18	moderate	59	moderate
19	moderate	60	low
20	low	61	moderate
21	low	62	low
22	moderate	63	low
23	moderate	64	moderate
24	moderate	65	high
25	low	66	moderate
26	moderate	67	moderate
27	moderate	68	moderate
28	moderate	69	low
29	low	70	moderate
30	low	71	low
31	moderate	72	low
32	low	73	moderate
33	moderate	74	moderate
34	high	75	moderate
35	high	76	moderate
36	moderate	77	moderate
37	moderate		
38	moderate		
39	moderate		
40	moderate		
41	moderate		

Summary	
Low	18
Moderate	51
High	8

Segments are continuous two-mile by two-mile analytic units, numbered consecutively from the Fourmile Bench site to the Arizona-Nevada border.

proposed line, a sensitivity ranking (Figure II-51) predicted that, of 94 two-mile square segments, 58 have moderate and 24 have high archaeological site sensitivity (Fish 1974).

Mohave to Serrano

The proposed route from Mohave to Serrano has received the most intensive preliminary survey for archaeological sites of any of the proposed line segments. Except for the Nevada portion from the Mohave plant to the California-Nevada state line, which was spot checked, the originally-proposed Mohave to Devers segment was sample surveyed by a University of California-Riverside survey team over its entire length, with on-the-ground survey of about 25 percent of the corridor width. The Devers to Serrano segment was less fully sampled, through spot checking of selected areas (Barker and Schlanger, 1974). Because of a late amendment to the original proposal, a 33-mile-long section from near Joshua Tree National Monument to southeast of Devers station was not surveyed, and no literature search has been made to determine whether known sites are present. The amended route crosses portions of the Agua Caliente Indian Reservation.

Along the corridor from the Nevada-California border to Serrano, the first site encountered is a workshop area of approximately 200 square meters. The site contains a number of silicaceous flakes and cores resulting from tool manfacturing activity. It is suspected that a number of tool rejects also occur at this site.

The second archaeological site contains silicaceous flakes, flake tools, and cores scattered over an extensive area. In addition, five rock rings were found, two of which form concentric circles. The site is at least 2 square miles, much of it within the proposed corridor. This site was apparently a major camp, workshop, and processing station, perhaps used repeatedly over a number of

FIGURE II-51

Moenkopi to Mohave
Archaeological Sensitivity

Segment	Rank	Segment	Rank
1	moderate	52	moderate
2	moderate	53	moderate
3	moderate	54	moderate
4	moderate	55	high
5	moderate	56	high
6	moderate	57	high
7	moderate	58	high
8	moderate	59	high
9	moderate	60	moderate
10	moderate	61	moderate
11	moderate	62	moderate
12	moderate	63	moderate
13	moderate	64	low
14	moderate	65	low
15	moderate	66	low
16	high	67	moderate
17	high	68	moderate
18	high	69	low
19	high	70	low
20	high	71	moderate
21	high	72	moderate
22	high	73	moderate
23	moderate	74	low
24	high	75	low
25	moderate	76	moderate
26	moderate	77	moderate
27	moderate	78	moderate
28	moderate	79	low
29	high	80	moderate
30	high	81	moderate
31	high	82	moderate
32	high	83	moderate
33	moderate	84	low
34	high	85	low
35	moderate	86	moderate
36	moderate	87	low
37	moderate	88	moderate
38	moderate	89	moderate
39	high	90	low
40	moderate	91	moderate
41	moderate	92	low
42	moderate	93	moderate
43	high	94	moderate
44	high	95	high
45	high		
46	moderate		
47	high	Summary	
48	high	Low	12
49	high	Moderate	58
50	moderate	High	24
51	moderate		

Segments are continuous two-mile by two-mile analytic units, numbered consecutively from Moenkopi substation to the Arizona-Nevada border.

seasons. Evidence suggests that the site may be affiliated with the San Dieguito Complex; little is known of such sites and the people who inhabited them, and relatively few are known in the area. This site must be classed as an important archaeological resource, potentially eligible for National Register inclusion.

As the proposed route continues west from the Devers substation, a complex of trails, rockshelters, petroglyphs, bedrock mortars, and artifacts was found. On the basis of recovered ceramics, historic artifacts, and features, it was concluded that one rock shelter was occupied occasionally as an overnight camp by the Cahuilla during the nineteenth century. The shelter is close to fresh water and enough edible plants to have provided human needs. The site is near a major trail.

The next archaeological site along the proposed route is a large village and refuse heap with associated rock shelters or storage caves, bedrock mortars, and grinding slicks (Appendix II-26). The site extends the width of the proposed corridor. A dirt road extends through portions of the site and during a recent fire a bulldozer trail was also cut through it. Still, a majority of the refuse deposit appears unaffected. This site appears to be worthy of nomination to the National Register.

The last site found in the proposed corridor is an aboriginal trail complex, extending westward from the Colorado River near Blythe to the San Bernardino Valley region. Trunk and subsidiary trails vary in width from 15 to 50 centimeters, and average somewhat more than 3 centimeters in depth. Where cobbles were available, a rim or ridge was constructed on each side of the trail. Several segments of the trail are crossed by or are close to the proposed line. Other sites, possibly served by the trail complex, are known to exist near the proposed transmission-line route. This complex also appears to merit National Register nomination.

Mr. Ike Eastvold, representing the Society for California Archaeology, has volunteered information for the portion of the proposed route which would cross the Lakeview Mountains southwest of Banning. Numerous prehistoric rock art sites, which Eastvold believes qualify for National Register consideration, lie within 1 mile of the proposed line. The line would be visible from five or more of these sites.

Northern Kaiparowits to Mohave preferred alternate

Except for the section from Eldorado substation to the Mohave plant, this proposed route is identical to the Kaiparowits to Eldorado proposal. University of Nevada archaeologists made a partial survey of the added portion (Brooks, Larson, and King, 1975), finding one extensive core tool lithic site and a sherd (pottery fragment) site. These sites have not been evaluated for eligibility for National Register nomination.

Arizona Strip preferred alternate

The Arizona Strip preferred alternate proposed route differs from the Kaiparowits to Eldorado and Northern Kaiparowits to Mohave proposals by departing from the alignment for 108 miles, crossing the Arizona Strip more directly from near Pipe Spring National Monument to the California Wash.

The proposed route was examined very superficially by helicopter in March, 1975, by archaeologists of Arizona BLM and SCE. It was agreed at that time that potential archaeological values in the proposed corridor are considerably higher than would be found on the more northern route that this proposal replaces.

A Museum of Northern Arizona sampling survey conducted later in 1975 for SCE (Hunt and McPherson 1975) examined 32 half-mile transects within 20 of 38 possible 4-square mile links. These transects were chosen to provide proportionately representative examination within each of the several distinct topographic-vegetation zones identified. Sixteen sites were found in the 32 half-mile

transects, including lithic scatters, camp sites, food processing sites, and a utilized rockshelter. On the basis of this preliminary work, it is believed that this proposed route may prove to be one of the most sensitive archaeological segments of the entire transmission system.

History

Indian

The proposed transmission system would cross a broad range of physiographic provinces and geographic zones, containing one of the most complex of all North American areas of historic Indian occupation. Records, beginning with the Spanish military, missionary, and reconnaissance expeditions in the early sixteenth century, indicate that numerous changes have occurred in traditional tribal locations since prehistoric and early historic times. This is one area, however, where European-American intrusion had less of a displacing effect on traditional locations than was the case in many other areas. Many of the present reservation lands coincide fairly well with areas formerly occupied.

The following discussion relates general features of the ethnic and tribal groupings in the impact area. Where possible it traces these peoples to prehistoric cultures which left archaeological remains in the area. Since not all modern Indians reside on reservations, there are many locales crossed by the proposed transmission system that are in some sense "Indian lands."

Tribal groupings in the impact area include Navajo, Hopi, Pima, Maricopa, Papago, Hualapai, Havasupai, Yavapai, Mohave, Paiute, Chemehuevi, Cahuilla, Serrano (Morongo), Vanyume, Luiseño, and Cupeño (Agua Caliente).

Navajo

The Navajo and their near-relatives the Apache, both Athabascan-speaking groups, entered the Southwest relatively recently, probably during the 2 or 3

centuries preceding A.D. 1600. During the early historic period the Navajo were nomadic hunter-warriors, raiding widely through much of the northern part of the area. Adoption of the horse, introduced by the Spanish about 1680, extended their raiding capabilities.

The Navajo are thought to have first settled in the upper San Juan drainages by about 1550, where contact with Puebloan groups led to the acceptance, in modified form, of numerous Puebloan ideas and material traits. They gradually moved west and south, late in the eighteenth century (McGregor, 1965; Wormington, 1956) finally occupying the areas where they are now found. The present Navajo tribe is the largest in the United States, and occupies the largest reservation (Southwest Energy Study, 1972).

Navajo settlements are typically dispersed, low-density family house-groups appropriate to their patterns of land use. The Navajo have developed distinctive patterns, separate from the earlier Puebloan influence, approximately since the beginning of the nineteenth century. At that time they began distinctive traditions of sheepherding, weaving, cribbed-log hogan construction, and religious ceremonies. Agriculture represents a relatively small part of the overall Navajo economy, generally limited to family-scale farming.

An expanding population, and mandatory stock reductions since the 1930s forced many Navajo away from traditional patterns and into the wage-economy market. Fine silversmithing and weaving, and other tourist-oriented crafts supplement income.

A number of sacred landmarks having importance in ritual observances are recognized by the Navajo. Abandoned dwellings, personal shrines, and burial grounds are strictly avoided.

Hopi

The Hopi are the westernmost of modern-day Puebloans, with roots traceable to prehistoric Anasazi of the Colorado Plateau. Linguistically, culturally, and territorially the Hopi are isolated from other Shoshonean peoples, most of whom are found to the west in the Great Basin and in southern California (Kroeber 1925). The major Hopi villages are on three finger-like projections of Black Mesa, on a reservation surrounded by lands shared or controlled by the Navajo. Old Oraibi, dating to approximately A.D. 1300, is the oldest continuously-occupied settlement in the United States. There are 11 Hopi villages, several of which were recently formed apart from the traditional mesa setting (Fish, 1974).

The Hopi have resisted change throughout the historic period, and are among the most conservative of the Puebloans. Although annexed by the Spanish in 1598 and exposed to missionizing efforts, the Hopi remained independent and unconverted. Spanish rule was broken by combined Pueblo rebellion in 1680.

An emphasis on arid-land agriculture has contributed to the principally sedentary village life of the Hopi. Sheepherding is also important, but has not led to the mobile pastoral life typical of the Navajo. Water-control devices and dispersed farming locales allow adequate yield in spite of the probability of loss in some areas. Corn, squash, beans, fruits, chilis, tobacco, and, formerly, cotton, are principal cultivated plants.

The Hopi observe an elaborate ritual calendar, with ceremonies keyed to the agricultural cycle and directed to supernatural beings (Kachinas) which control the forces of well-being. The land itself is sacred, and a number of landscape features are considered sacred or important as ritual landmarks; these frequently are the sites of shrines, and are avoided for secular use.

The Hopi produce a greater variety and quantity of arts and crafts for sale than almost any other group; in recent years many Hopi have turned to outside employment to supplement other forms of income (Hessian and Frampton, 1974; Southwest Energy Study, 1972).

Upland Yumans

The Yuman-speaking groups of the northwestern Arizona Plateau, Hualapai, Havasupai, and Yavapai, were traditionally mobile hunters and gatherers who adjusted to seasonal cycles of food sources. The upland Yumans, sometimes referred to as the Pai, are believed to be descendants of the prehistoric Cohonina (Patayan) tradition of the same geographic area, dating to approximately A.D. 600 (Schwartz, 1966). The Havasupai, residing along the south rim of the Grand Canyon, tended to be more sedentary than the others. Because of the aridity of the area and extreme shortage of surface water, little farming was practiced by these groups. Native food sources were used, principally agave, yucca, cactus, pinyon, seed-bearing annuals, small mammals, and deer.

Hualapai and Havasupai are linguistically and culturally related; it is probable that they formerly comprised a single group, divided only recently, perhaps since the establishment of two reservations split a continuous population. The Yavapai are believed to be recent inhabitants of the area where they are found; the approximately 20,000-square-mile area is divided into three cultural subdivisions which the Yavapai themselves recognize (Hession and Frampton, 1974).

The mobile subsistence pattern, impermanent residence, and small, relatively fluid social groups have been deterrents to elaboration of the culture, social organization, and ritual life of the upland Yumans.

Pima, Maricopa and Papago

The southern Arizona portion of the impact area was occupied historically by peoples who are discussed together here because of geographic location rather than for ethnic or linguistic reasons. The Uto-Aztekan-speaking (Piman) Pima have traditionally occupied the Gila River Valley, and are believed to be descendants of the River Hohokam. The Papago, who speak a closely-related Piman dialect, occupied the drier desert areas south of the Gila Valley, and are

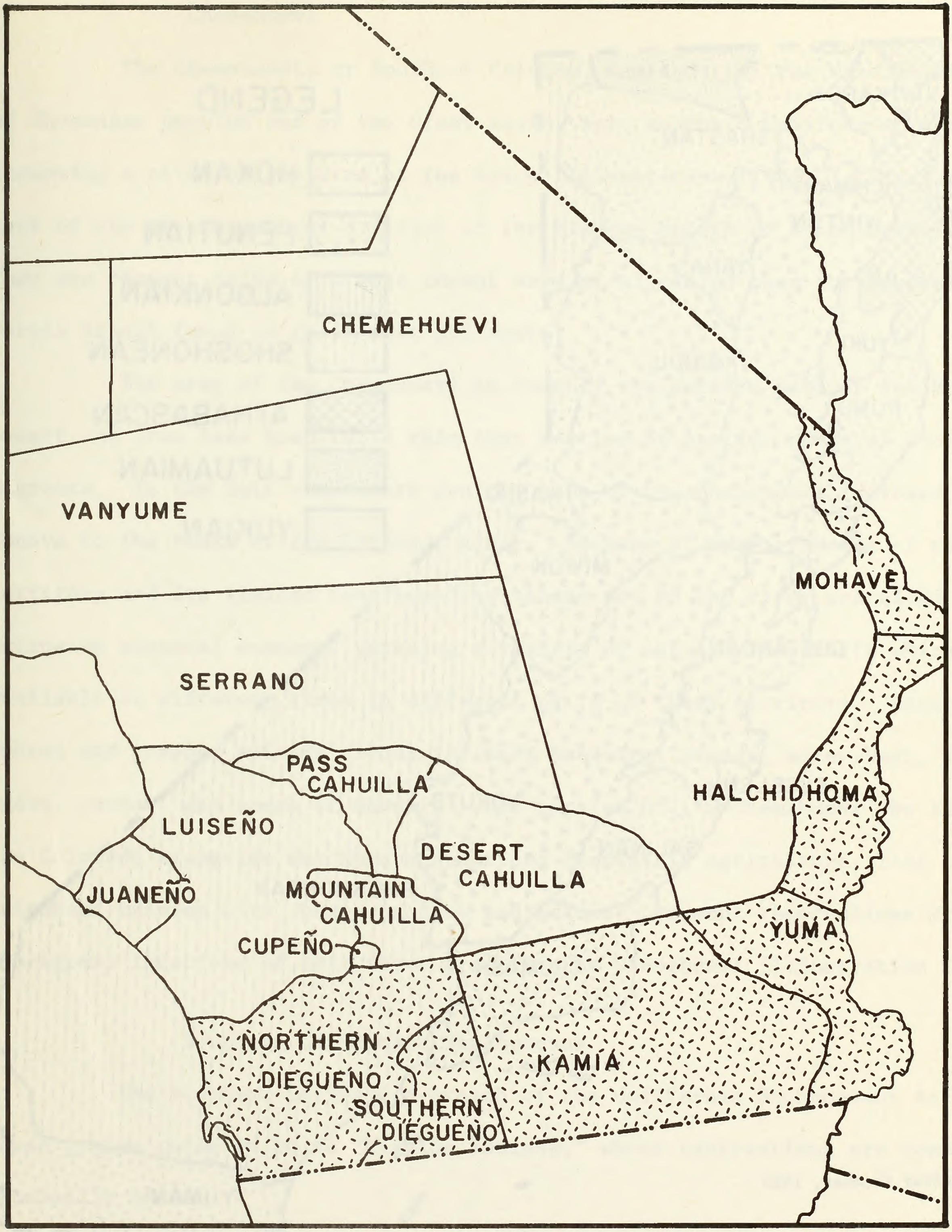
thought to be modern representatives of the Desert Hohokam. The Yuman-speaking Maricopa are believed to be relatively recent migrants from the lower Colorado River Valley.

The historic economic base of these groups has been irrigated agriculture, cattle grazing, agricultural employment, and incidental occupations such as cutting firewood. Weaving of yucca basketry produces supplemental income. The river groups have a more reliable agricultural production, and grazing has greater importance to the Papago. Employment in industry is becoming increasingly important with the development of copper resources in the Papago Reservation vicinity. Numerous colonies in southern Arizona towns and cities are drawing wage workers off-reservation.

Mohave

Mohave Indians are a segment of a larger Yuman-speaking (Hokan) population which once occupied most of the Mohave Desert, extending from both banks of the Colorado River westward to the Pacific Ocean. Shoshonean peoples, some 1,500 years ago (Kroeber, 1925), are thought to have forced Mohave retreat to the Colorado Basin, where Yuman peoples were concentrated at the time of Spanish contact (Illustrations II-36, II-37).

The Mohave were primarily an agricultural people after their concentration on the Colorado, planting corn, beans, squash and melons in the alluvial soils. They did not gather in large settlements, however, and houses within their villages were scattered. The Mohave traveled into the desert mountains in search of game and wild plants not available along the river, following well-marked trails some of which might have been established prehistorically. They participated in a vast trading system extending across the Mohave Desert to the Pacific Ocean, but the bulk of their living centered around the Colorado River. The Mohave today remain within a portion of their former territory (Illustration II-38).



After Kroeber, 1925

ILLUSTRATION II-36

Southern California Tribal Locations

ILLUSTRATION II-37

Linquistic Groups and Families in California

Chemehuevi

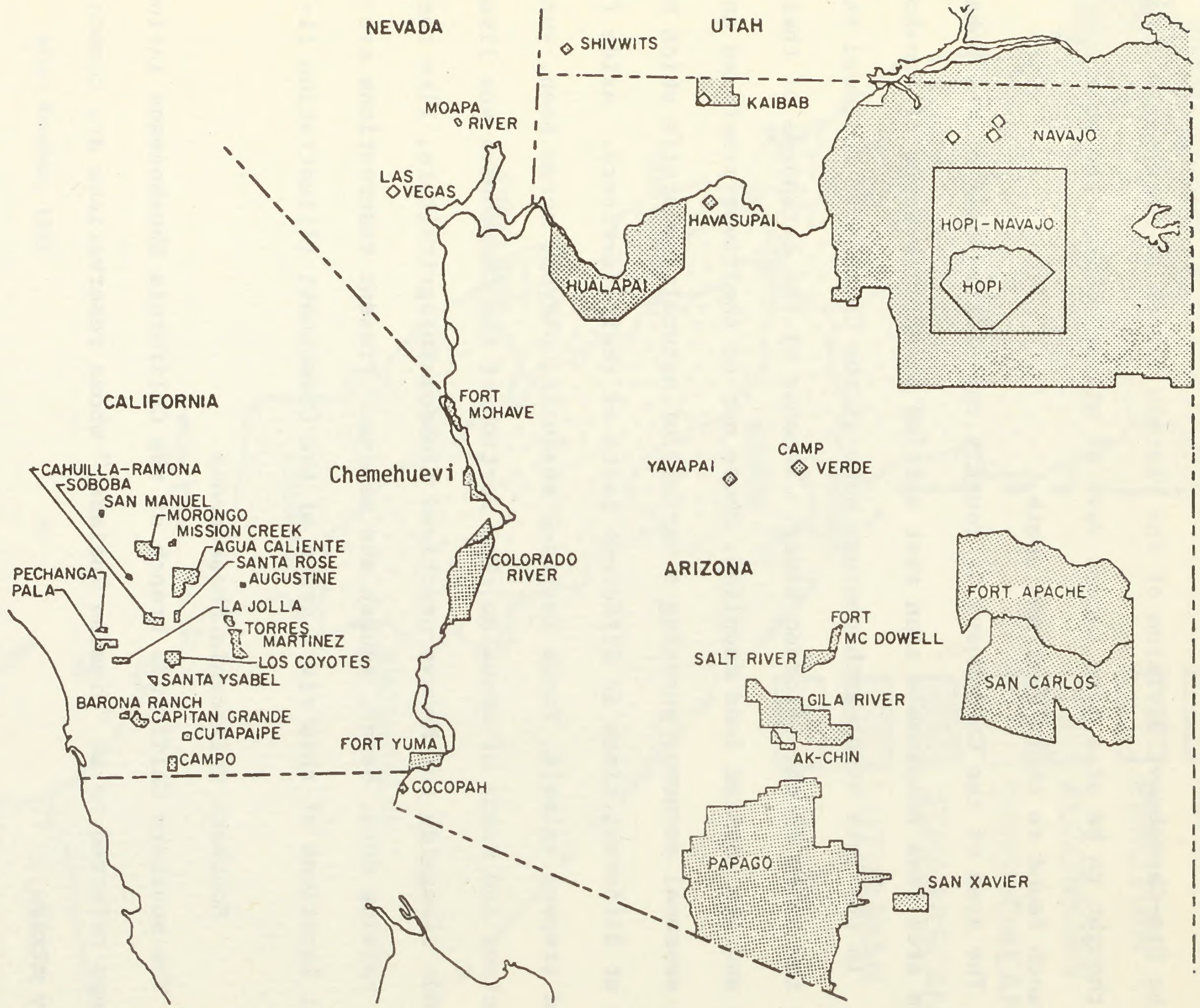
The Chemehuevi, or Southern Paiutes, were part of the massive expansion of Shosonean peoples out of the Great Basin into southern California, eventually occupying a third of the area of the state (Illustration II-36). Linguistically part of the Ute-Chemehuevi division of the Plateau Branch of Shoshonean languages, they are thought to be of a more recent wave of migration than the southern California branch found to their west and south.

The area of the Chemehuevi is roughly the eastern half of the Mohave Desert, an area less hospitable than that settled by earlier waves of Shoshonean migrants. In the late eighteenth century some of the Chemehuevi followed the Mohave to the banks of the Colorado River. Because of the harshness of their territory and its limited food supplies, those not on the river practiced an extensive seasonal economy, pursuing a variety of natural foodstuffs which became available at different times in different parts of their territory. Aside from hunted and trapped animals, foods included mesquite, pinyon, screw bean, yucca, agave, cactus, and seeds of annuals. The portion of the Chemehuevi who lived on the Colorado alongside the Mohave practiced floodplain agriculture, like their neighbors raising corn, beans, squash and melons. Present reservations are the aboriginal locations of this river group of the Chemehuevi (Illustration II-38).

Southern California Shoshoneans

The southern California branch of the California Shoshoneans includes those groups referred to as "Mission Indians," whose reservations are commonly ethnically mixed.

Luiseno and Cahuilla are linguistically close groups which occupied the southern portion of the impact area, comprising in all some six ethnic units. The Cupeno or Agua Caliente are among these. The Serrano division, including four groups, adjoins the Luiseno-Cahuilla division on the north, and is represented



Southwest Energy Study, 1972

ILLUSTRATION II-38

Indian Reservation in Greater Transmission System Impact Area

in the impact area by Serrano and Vanyume (Illustration II-36). "Morongo" is a term used to refer to the Serrano, and is the name of a reservation near Banning shared by the Serrano and Cahuilla (Illustration II-38).

Southern California Shoshoneans were culturally similar, although numerous differences exist. Economies were generally similar, with varying emphasis on the animal and vegetal foods available in their territories. Most groups had access to a range of environmental zones and elevations which provided a wide array of seasonal products. Acorn, mesquite, agave, pinyon, yucca, various bulbs and roots, green plants, and seeds from annuals were the principal vegetal foods gathered. Large and small mammals, birds and reptiles were hunted. Such patterns of subsistence were largely disrupted in early historic times when these peoples were forced by missionaries to live on rancherias at Spanish Catholic missions. Some mission Indians have managed to retain their language, religion and social traditions in attenuated form. The southern California reservations are among the smallest in the impact area.

European-American

Numerous traces of the European-American entry into the western region are found in the transmission system impact area.

Recorded history began in 1527 with the Spanish being the first Europeans in the area. A principal influence was contributed by missionizing efforts among the Indians and the establishment of routes connecting centers of Spanish interest. In 1776, Fathers Dominguez and Escalante set out from Santa Fe, New Mexico to find a route to the missions in southern California. Their expedition through the Great Basin provided basic information for later westward expansion of the nation. The Dominguez-Escalante Route and other routes and trails are shown in Illustration II-39.

The Spanish Trail was established in 1829 and 1831 by traders and trappers looking for a route between southern California and Las Vegas. This route was used by trading caravans and others until after the accession of New Mexico and California. Other expeditions which followed essentially this route were the Jedediah Smith Expedition of 1825-27, Antonio Armijo Expedition of 1829, the Yount-Wolfskill Expedition of 1830-31, the John C. Fremont Expedition, 1844, and the Parley P. Pratt Expedition in 1849.

Shortly after the Mormon pioneers arrived at the Great Salt Lake in 1847 they began to establish contact with California. In 1848, Jefferson Hunt, O.P. Rockwell and others demonstrated the feasibility for a wagon route between Salt Lake and Los Angeles, following the Spanish Trail from the rim of the Great Basin. In 1851 an expedition of 520 people reached the coast and founded a Mormon settlement at Rancho de San Bernardino. Once these beginnings were made, church authorities planned to secure the corridor by founding a string of settlements between Salt Lake and San Bernardino, including one at Las Vegas, Nevada.

The gold rush brought prosperity to the Mormons in Utah, allowing them to extend colonies along the trail to the Pacific ports. During this period, Mormon colonists founded settlements in southern Utah and in much of southern Nevada and northern Arizona. The Old Mormon Immigrant Road was established and used by early Mormon pioneers as a route to Las Vegas and southern California from St. George and vicinity.

In the 1850s expeditions led by Sitgreaves and Whipple were sent to locate a railroad route to the Pacific, through Arizona. Settlers began coming into the region in 1854 to mine and ranch. Gold was discovered during this period, and many mining activities sprang up in the Prescott region.

Settlers faced a series of problems with the Indians, as trouble with major tribes plagued settlers from the earliest expedition. Navajos were the

ILLUSTRATION II-39

Historic Trails and Routes

first Indians to challenge the newcomers' right to the land, raiding surrounding tribes as well. Peace was negotiated with the Navajos in 1864; however, the Apache then became the focus of conflict, and for 40 years they were the major human factor in retarding settlement of the southwestern territories.

After the Mexican-American War (1846-1848) all of modern Arizona north of the Gila River was ceded to the United States. The remainder was ceded in 1854. Territorial government was established in 1863, with Prescott the first seat of government. Phoenix became the agricultural center, as the first irrigation system was constructed in 1867, following in part prehistoric Hohokam canals.

Establishment of pioneer trails across northern Arizona by Army mapping crews in the mid-1800s led to wagon roads and ultimately railroads. Today, the Santa Fe Railway and U.S. Highway 66 closely parallel a wagon road opened by Edward Beale in 1857 between the Rio Grande and the Colorado. Early settlements on Coconino and Haulapai plateaus centered around the Santa Fe Railroad route and the lumbering and ranching industries.

The Old Government Road (Mohave Indian Trail) used by Jedediah Smith connects with Fort Piute. This is one of the forts established in the early 1860s to protect settlers from the Indians. Although it was not a complete military establishment, this outpost provided relief for soldiers and their mounts while on patrol.

The Navajo Trail was created as Navajo Indians raided settlements in northern Arizona, southern Utah and Nevada during the 1870s.

Temple Trail is the route used from 1871 to 1876 to haul timber from Mount Trumbull to St. George, Utah for the Mormon Temple. Over a million board-feet of timber were hauled the 80 miles by oxen-pulled wagons. Rocks were laid by hand to build up the roadway, to aid the wagons in moving up and down Hurricane Cliffs. Marks of the wagon wheels are still visible on the rocks in this area.

Principal settlement by European-Americans began with the search for gold, silver, copper and quartz in the mid-1800s. Copper and silver booms brought prospectors and tourists, leading to the establishment of stage and rail lines. Kingman, Arizona began as a railroad stop and important trade center for the surrounding ranching and mining communities.

Camp Young (also known as Patton's Camp or the California-Arizona Maneuver Area) was the largest training area ever established by the United States Army. From 1942 until early 1944, more than a million men were trained in the California desert, at first under the direction of General George S. Patton, for North African and European campaigns. The camp covered 55,000 square miles and was developed into a mock theatre of operations.

Limestone quarry impact area

Limestone at the proposed site was deposited by an ancient lake and is essentially devoid of fossils. The few that have been found are shells of little value other than to aid in the determination of age.

A total of 18 archaeological sites was identified through clearance investigations associated with 20 drilling locations and their associated access roads. Two major travel routes have also been cleared. Seven sites were located on State lands and 11 on Forest Service lands. Six types of sites were located: (1) Lithic scatter sites, (2) rock shelter/habitation sites, (3) lithic/ceramic campsites, (4) habitations, (5) lithic campsites and (6) prehistoric and historic overlap sites. Projections would place additional sites in the impact area on knolls or ridges associated with springs and along the east fork of the Sevier River.

History adjacent to the area includes the settling of Johns Valley and the town of Widtsoe.

Recreation

Kaiparowits Plateau impact area

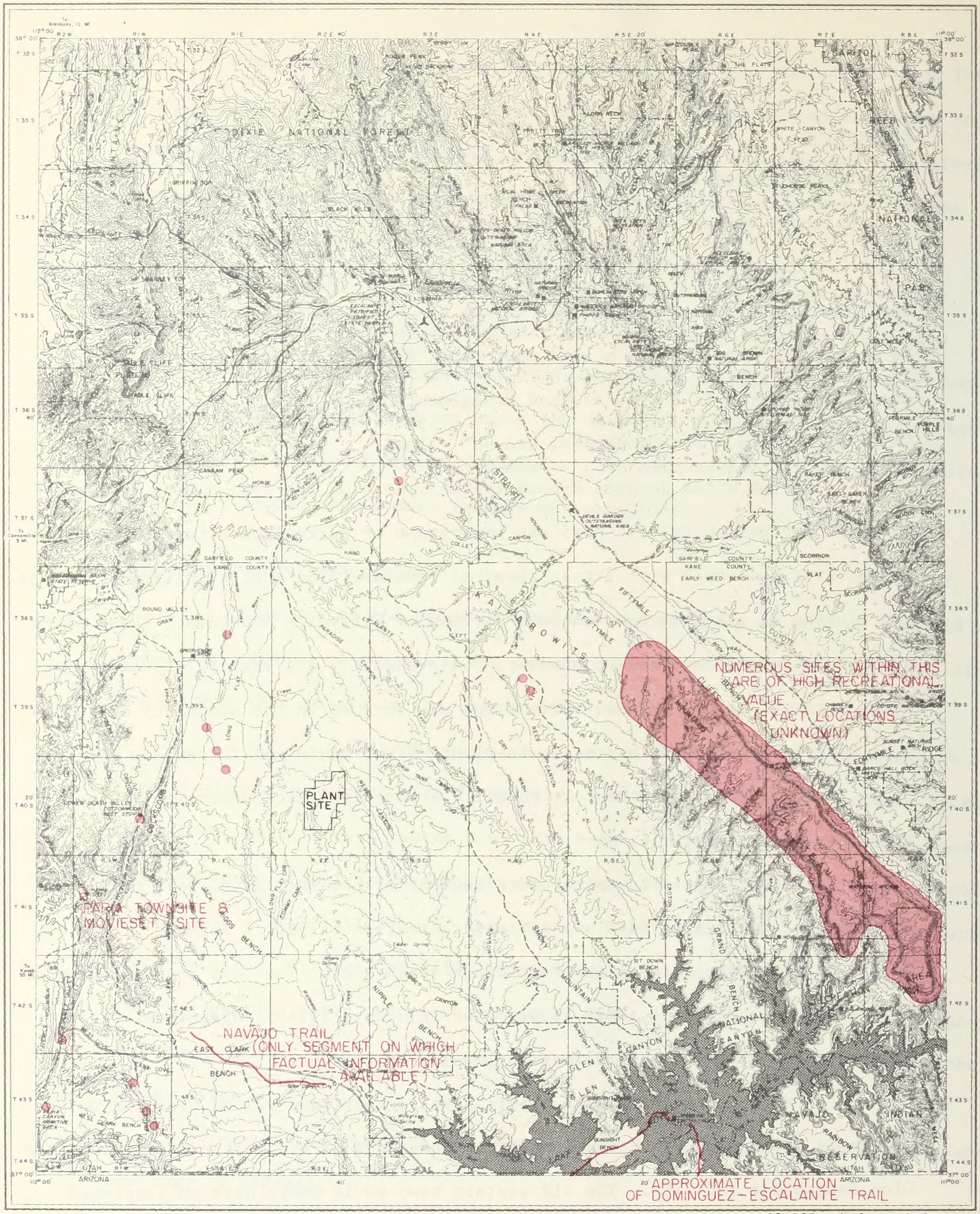
Cultural values

Known historical and archaeological resources within the impact area that have significant recreational values are shown in Illustration II-40. To be considered significant, a site must rate "B" or better based on the quality evaluation system in Bureau of Land Management Manual 1611. Under this system, "A" = high value, "B" = moderate, and "C" = low.

A few sites located around the periphery of the impact area have significant recreation value. Most are pictograph or petroglyph sites. Ruin sites in the area are small with little physical remains. The most significant area is the cluster of sites on the southern portion of Fiftymile Mountain. These sites are not large and impressive; however, their quantity and variety create a high human interest value. Higher value sites are located in the secondary influence zone such as Kanab Creek Drainage, Escalante River Basin and in canyons which drain into the upper half of Lake Powell. Archaeological inventories in these areas are incomplete.

The Old Paria townsite and a segment of the Escalante Trail that crosses the impact area have significant recreation value. A segment of the Navajo Trail passes through the East Clark Bench area. The only documentation on this trail is a March 14, 1877 survey plat (Lindsay, 1974). Additional research is needed to determine the recreational value of this site.

Two features of modern origin have recreational value: Glen Canyon Dam and movie props near Old Paria townsite. Thousands of visitors annually tour the Glen Canyon Dam facility. The old western town movie props have an increased public interest value due to proximity of the Old Paria townsite and the multicolored cliff formations surrounding the area (Illustrations II-41 and II-42).



SOURCE: LAMAR LINDSAY, 1974

ARCHEOLOGICAL SITES

HISTORIC SITES

HISTORIC TRAILS

ILLUSTRATION II-40

Cultural Sites Having Significant Recreational Value

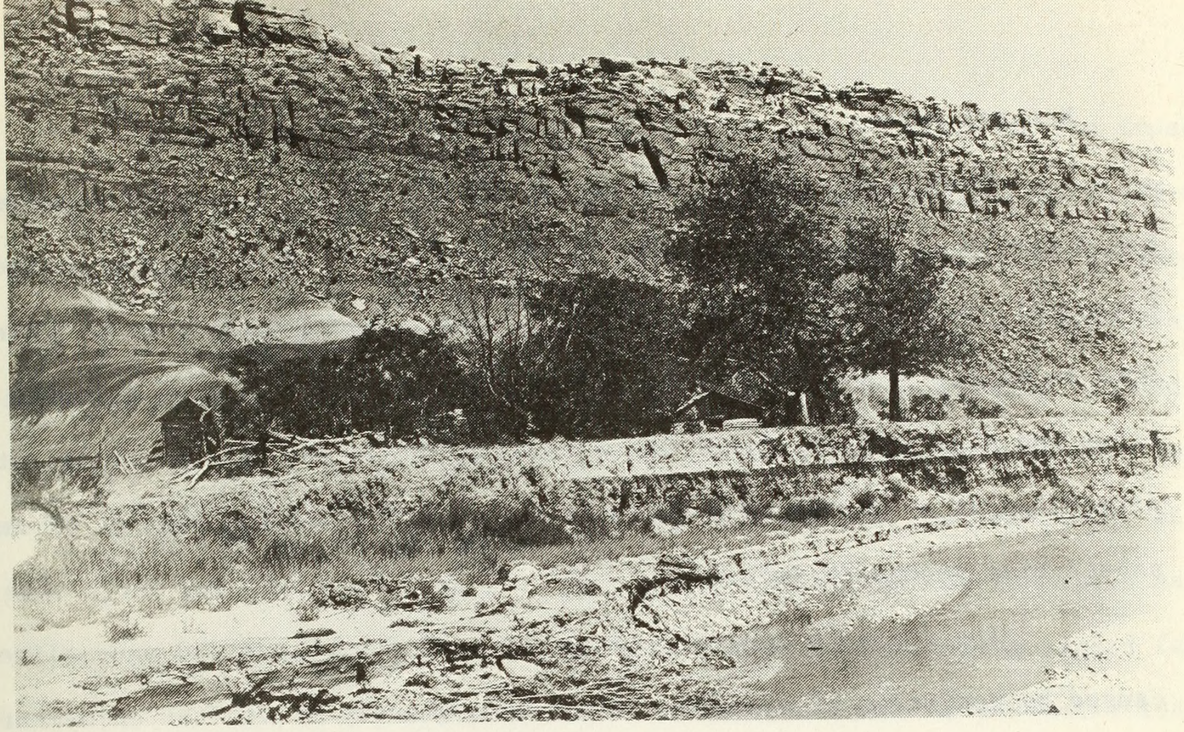


ILLUSTRATION II-41

Old Paria Townsite

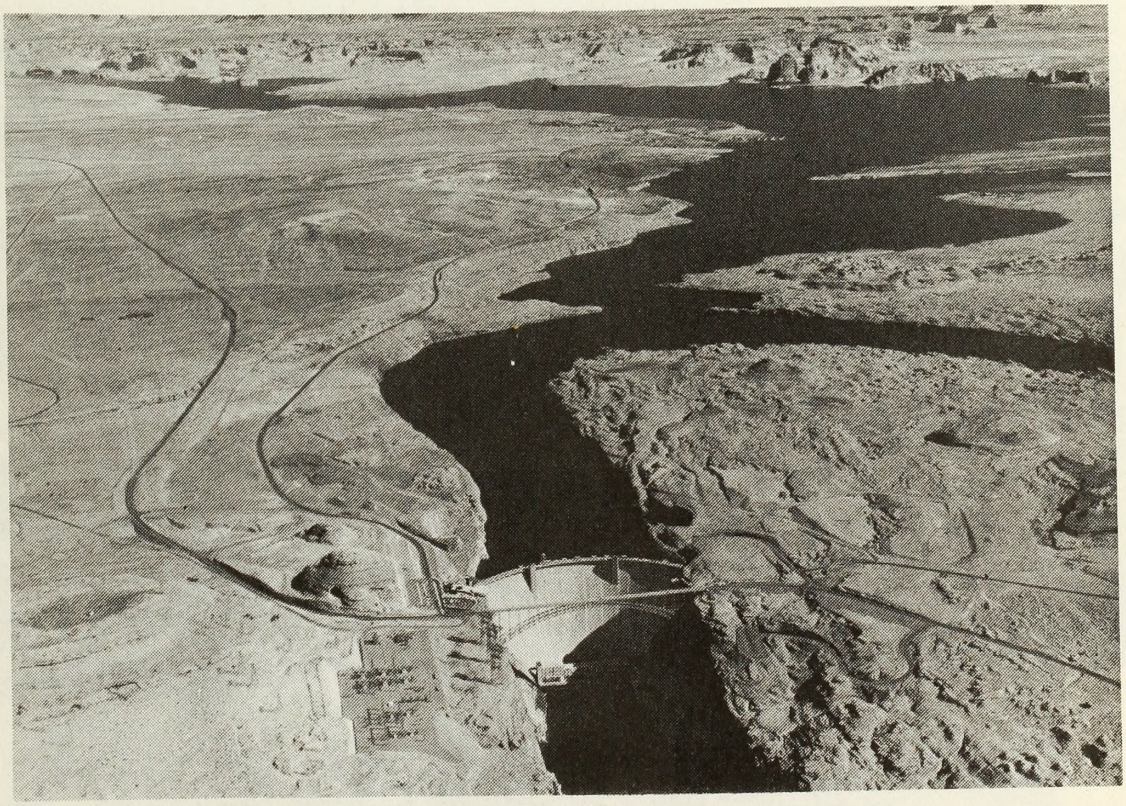


ILLUSTRATION II-42

Glen Canyon Dam

Natural values

Many recreational activities in the proposed Kaiparowits project area are directly or indirectly related to inherent natural values (i.e., geological, botanical, zoological, air and water) of the surrounding territory. Since the area is remote, these values are relatively undisturbed. The following descriptions and observations concerning these natural values relate not only to the direct impact area, but also to important peripheral sites that could incur substantial secondary impact.

The region's geology, featuring many formations and unusual rock shapes caused by centuries of erosion, contributes greatly to visitor enjoyment and the area recreation potential. Steep-sided canyon walls in multicolored layers, plateaus, and escarpments provide recreational values for the sightseer or photographer (Illustration II-43).

ILLUSTRATION II-43

Sandstone Formation - Escalante River

The most prominent and spectacular geological feature of the impact area is the East Kaibab Monocline, known as the Cockscomb (Illustration II-44). It extends approximately 150 miles in a north-south direction on the project area's western edge and has stratigraphic displacements of 2,000 - 4,500 feet with the downwarp to the east. Although this fold has been greatly reduced by erosion, it is still a prominent topographic feature visible for miles. For example, at Shurtz Gorge where the Paria River intersects the Cockscomb, it stands 1,150 feet above the river. This upwarp has tilted the formation as much as 60^{o} to the east. The more resistant rocks have weathered in a jagged fashion, giving the area its name. Approximately 150 million years of sedimentation is exposed along the Cockscomb.

ILLUSTRATION II-44

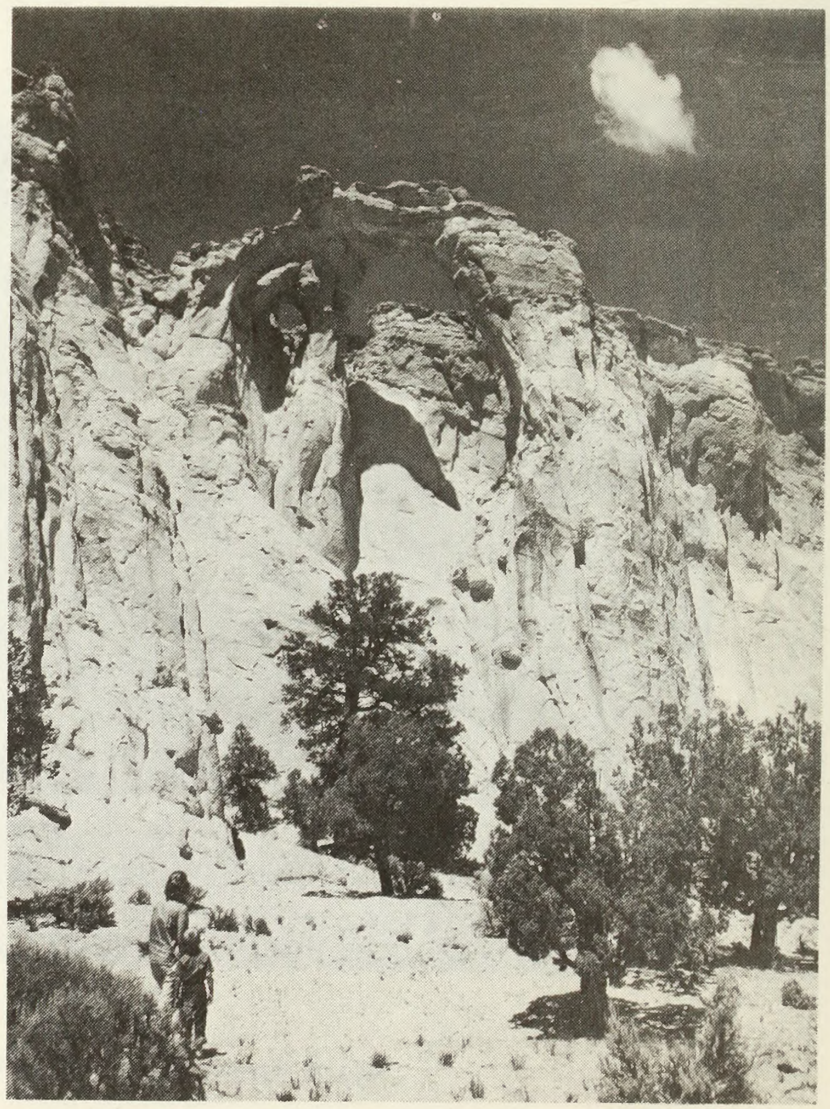
The Cockscomb

Grosvenor Arch, which has high scenic value, is located near the northern end of the Cockscomb. This beautiful double arch, composed of two formations, lies at the east end of Butler Valley (Illustration II-45). The lower yellow sandstone forming the bulk of the walls belongs to the Windsor formation. Cap of the arch consists of the darker sandstone conglomerate Dakota formation. Access to Grosvenor Arch is by dirt road maintained by the county. The Bureau of Land Management (BLM) maintains a small picnic area near the arch.

Kodachrome Flat, approximately 20 miles northwest of the Fourmile plant site, is a state-managed park characterized by many spire-like structures of the Entrada and Windsor formations. Colors range from deep-red to light-brown, to white.

ILLUSTRATION II-45

Grosvenor Arch



Extensive coal deposits are found in the Straight Cliffs sandstone. At several places, these deposits are exposed in the steep gray-to-yellow cliffs. Such deposits scattered in various locations north of U.S. 89, have potential as educational interpretive sites.

Fossilized plants and evidence of marine life are found in the Kaiparowits, Straight Cliffs, Tropic, Dakota, and Carmel formations. Hunting for fossils, petrified wood, and rocks is becoming a popular recreational activity in the area. Although these fossils occur frequently in localized areas, they are a finite non-renewable resource and vulnerable to heavy-collecting pressure. Federal and state legislation limits such collecting activity to protect the resource for enjoyment by future generations.

Geologic structures that surround Lake Powell contribute to spectacular scenic values of the lake. The contrast between blue waters, sharply eroded cliffs and multicolored canyon walls is found in few other places in the country. These erosional features are found mainly in the Navajo formations, with caps of Windsor, Entrada, and Carmel formations.

Several national parks and monuments within the secondary impact zone were originally established because of their unique geologic formations. These include Grand Canyon, Zion, Cedar Breaks, Bryce Canyon, Capitol Reef, Canyonlands, Natural Bridges, and Rainbow Bridge.

Botanical recreation values of this area are negligible. A variety of wildlife species is native to the impact area (see preceding section on wildlife). Animal observations may provide recreational enjoyment but are not considered of primary importance.

Primitive-wilderness values

The Kaiparowits Plateau impact area is interlaced with numerous low-quality roads and trails. These roads and trails have made it a popular area for "back country" exploring via off-road vehicles.

The National Park Service is conducting a wilderness study of the Glen Canyon National Recreation Area. Much of the land surrounding Lake Powell is inaccessible and undeveloped. Consequently, it has high potential for primitive management.

The Escalante River Drainage is another area in the secondary impact zone that has been recognized for its primitive values. Escalante River is identified in Section 5D of the Wild and Scenic River Act as a potential wild and scenic river. The BLM has designated three outstanding natural areas (see Illustration II-46). The Escalante River Drainage has been mentioned frequently by conservation organizations as having high primitive or wilderness value.

In the immediate zone surrounding the impact area, the BLM (Paria Unit Resource Analysis, 1970) has identified three areas (see Illustration II-46 for location) as having significant primitive values:

Paria Canyon Primitive Area

In 1969, the Secretary of the Interior designated public lands along the lower Buckskin and Paria rivers as the Paria Canyon Primitive Area. It is characterized by deep, narrow, steep-walled canyons cut into sandstone of the Glen Canyon group. In many places, the streams have undercut the rim, making an upward view of the sky impossible. The canyon has become very popular with hiking groups and is a significant tourist attraction. The area contains 3,957 acres.

Hackberry Canyon roadless area

All the characteristics necessary to qualify for primitive area designation are possessed by this roadless area. It is extremely scenic with many sandstone formations and deep side canyons cutting through multicolored formations. More than 2,000 feet separate the top of the towering White Cliffs and the canyon

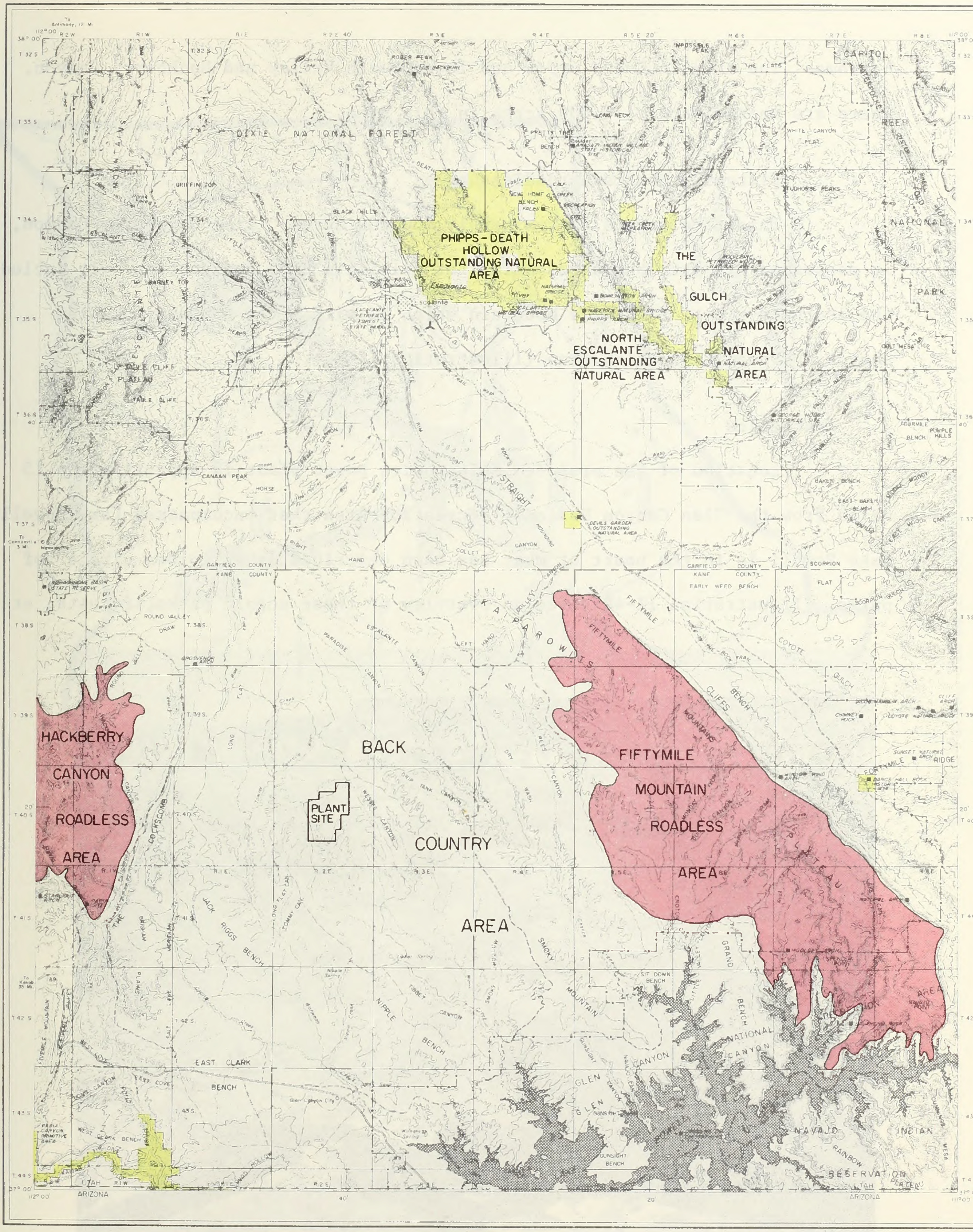


ILLUSTRATION II-46

Primitive Values

bottoms. The area includes upper and lower Death Valley and Hackberry Canyon. There are approximately 70,000 acres in this area.

Fiftymile Mountain roadless area

This area covers approximately 200,000 acres. Like Hackberry Canyon, it possesses all attributes essential for primitive area designation. It includes the southern tip of Fiftymile Mountain which is within the boundary of Glen Canyon National Recreation Area (Illustration II-47).

Aesthetics

Location of the proposed Kaiparowits power plant is approximately 15 miles from the Glen Canyon National Recreation Area that encompasses Lake Powell. Lake Powell is in the heart of what has been described as a "golden circle" of parks. Illustration II-48 gives an overview of these scenic parks, forests, etc.

ILLUSTRATION II-47

Lake Powell view northeast to Fiftymile Mountain

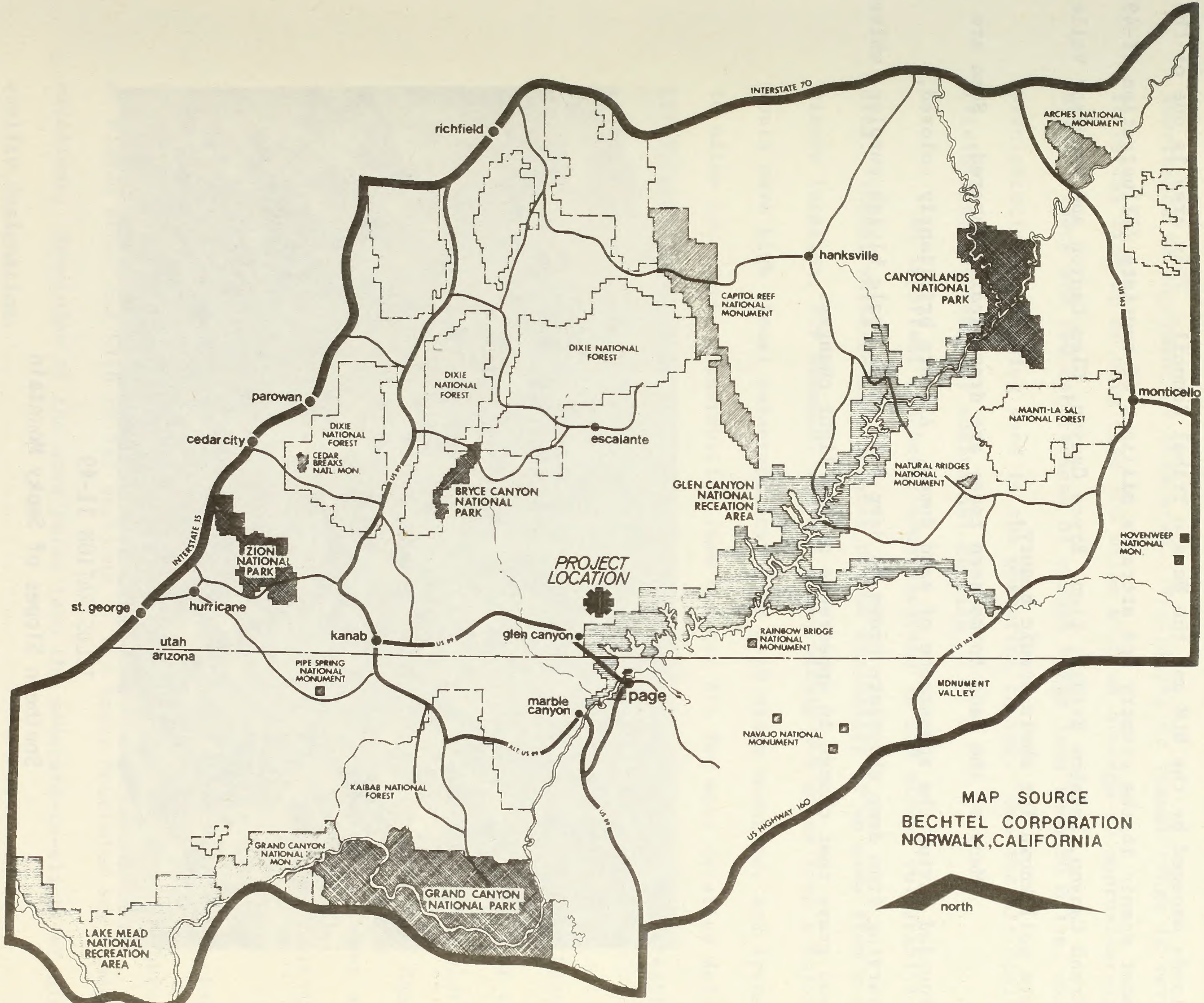


ILLUSTRATION II-48

Scenic Parks, Forests and Monuments

within this area are 15 national parks, monuments and recreation areas as well as nine units of the national forest and millions of acres of highly scenic lands managed by the BLM and the Navajo Tribal Council. This area is one of the most scenic in the country and attracts millions of tourists (Illustration II-49). Grand Canyon, Rainbow Bridge, Zion, Bryce Canyon, Glen Canyon and Monument Valley are well known for their scenic beauty.

Many of the land forms seen today are dramatically layered. Some are rounded having the appearance of sand dunes. All are brilliantly colored, varying from deep chocolate brown to deep red, pinks, pale bluish purples, whites and grays that change in appearance as the light changes.

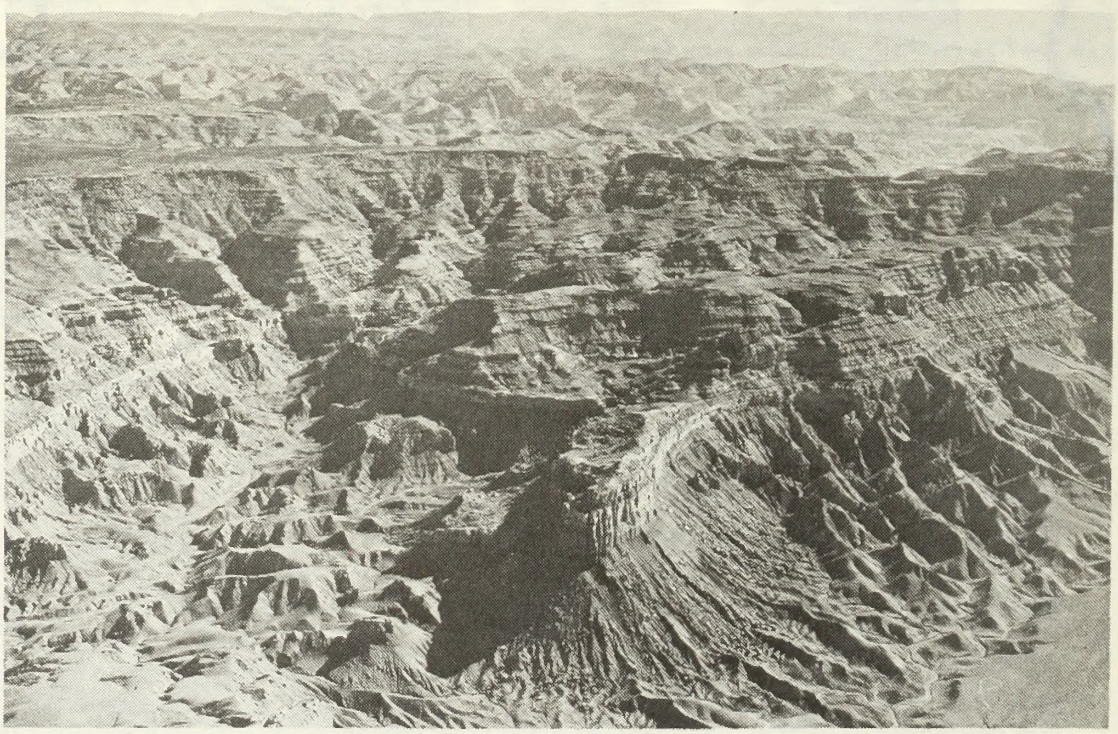


ILLUSTRATION II-49

Southern Slopes of Smoky Mountain

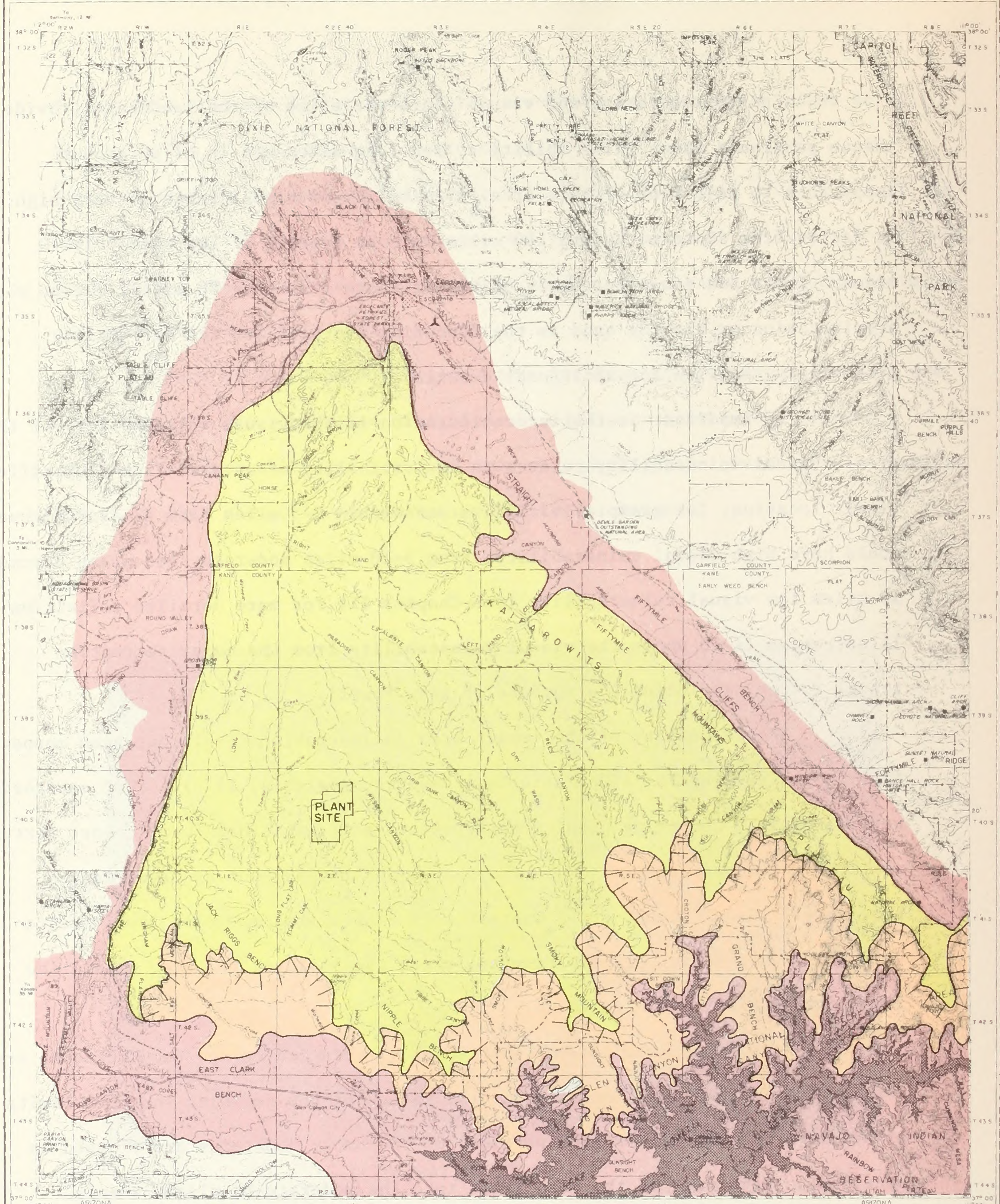
Sparse vegetation and visual characteristics of the landscape provide unique panoramic views. The ability to see long distances is of paramount importance to enjoyment of this area. Visibility or visual range is very high. It varies from 20 to more than 100 miles with an average of approximately 70 miles. There are few occurrences of visual range less than 30 miles, except when precipitation or blowing sand is the obscuring factor. See the Air Quality (Visibility) section for additional details.

An important aesthetic consideration is the visual vulnerability of the area. Visual vulnerability relates to the visibility of an area from a specific viewer location; for example, visible areas within 0-5 miles from a major highway would have high visual vulnerability, from 5-10 miles moderate, and areas beyond 10 miles low visual vulnerability (see Chapter III for more detailed definition.) Illustration II-50 shows the visual vulnerability from the major recreation travel routes, including the surface of Lake Powell.

Scenic quality of the impact area (Illustration II-51) has been mapped from an analysis by the BLM (Paria Unit Resource Analysis, 1970). Four categories were derived by comparing scenic characteristics (i.e., line, form, color, texture, etc.) of the impact area with other areas in the region such as Bryce Canyon, Lake Powell, Zion Canyon, etc. Overall, the impact area has much lower scenic value than surrounding areas. However, there are isolated features within the impact area which have high value.

Within the impact area, Lake Powell, Paria Canyon and the Cockscomb are considered of exceptional scenic quality. Steep slopes defining southern limits of Nipple Bench and high relief portions of the Smoky Mountains are classed as excellent. Remainder of the area falls into the moderate-to-slight scenic quality designation.

Illustration II-52 shows visual relationship of the proposed power plant to key observation points. The proposed installation is directly visible from



HIGH VISUAL VULNERABILITY
MEDIUM VISUAL VULNERABILITY
LOW VISUAL VULNERABILITY
HIGHLY VISUAL CLIFF FORMATION

ILLUSTRATION II-50

Visual Vulnerability

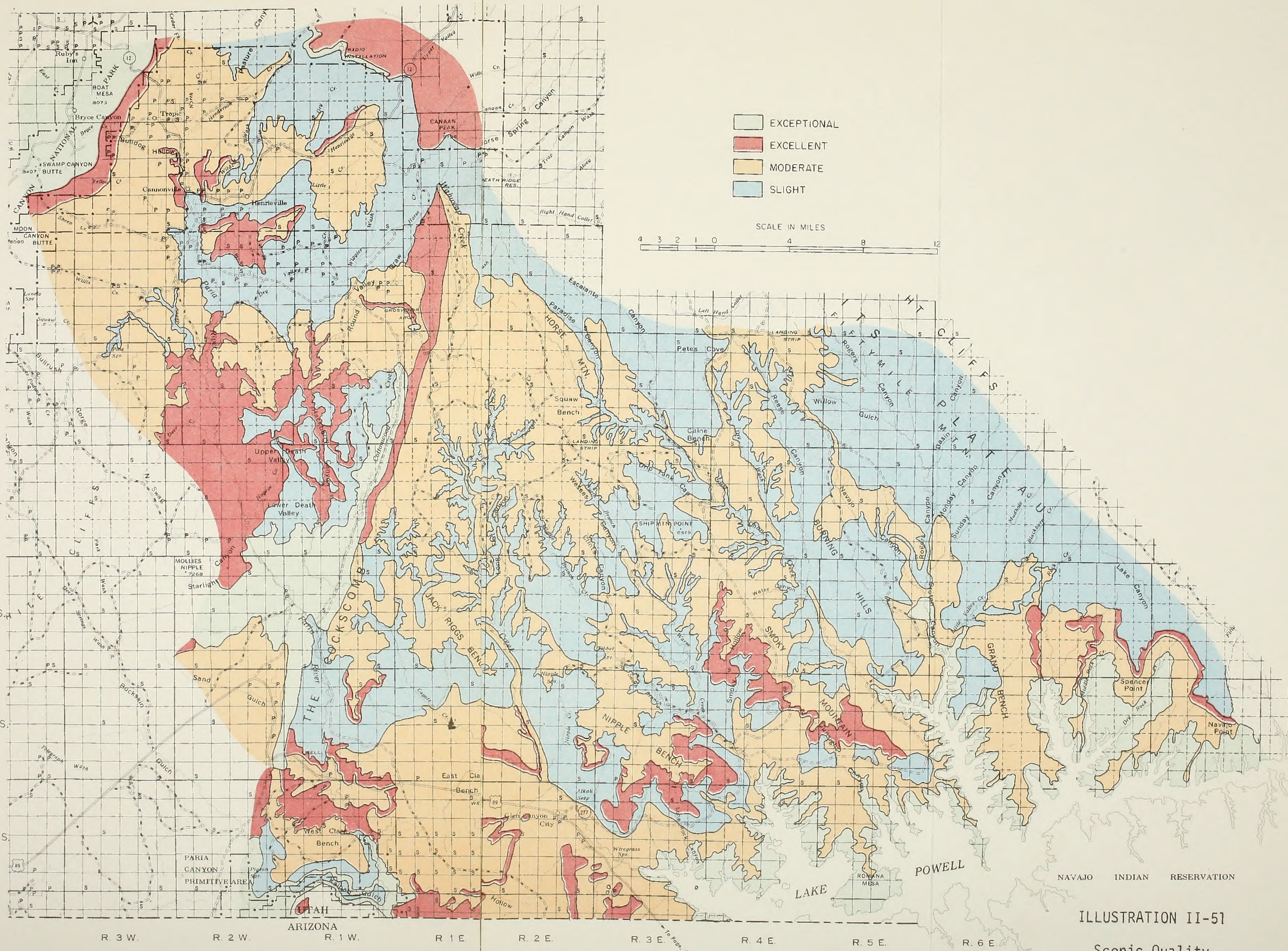
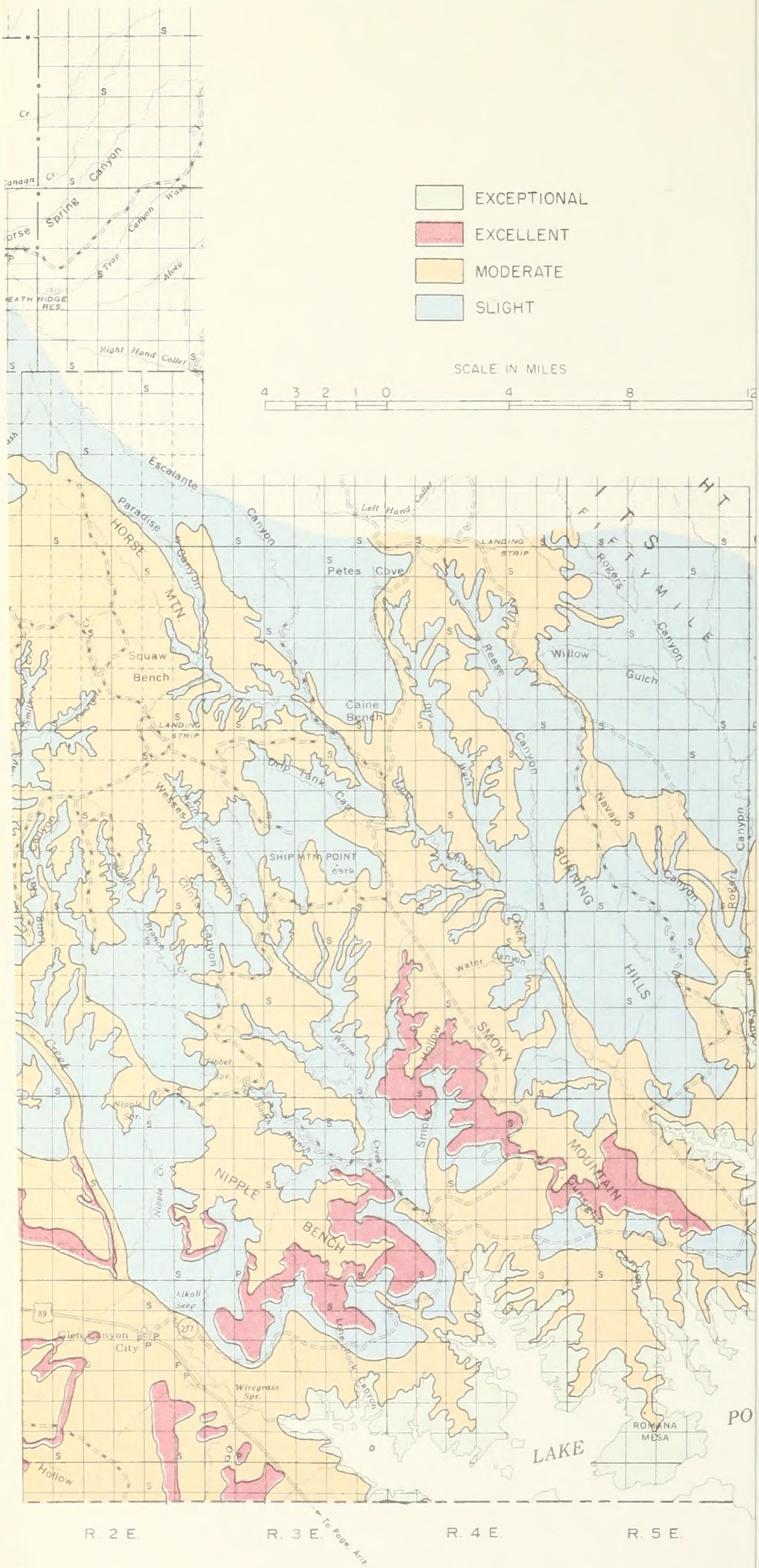
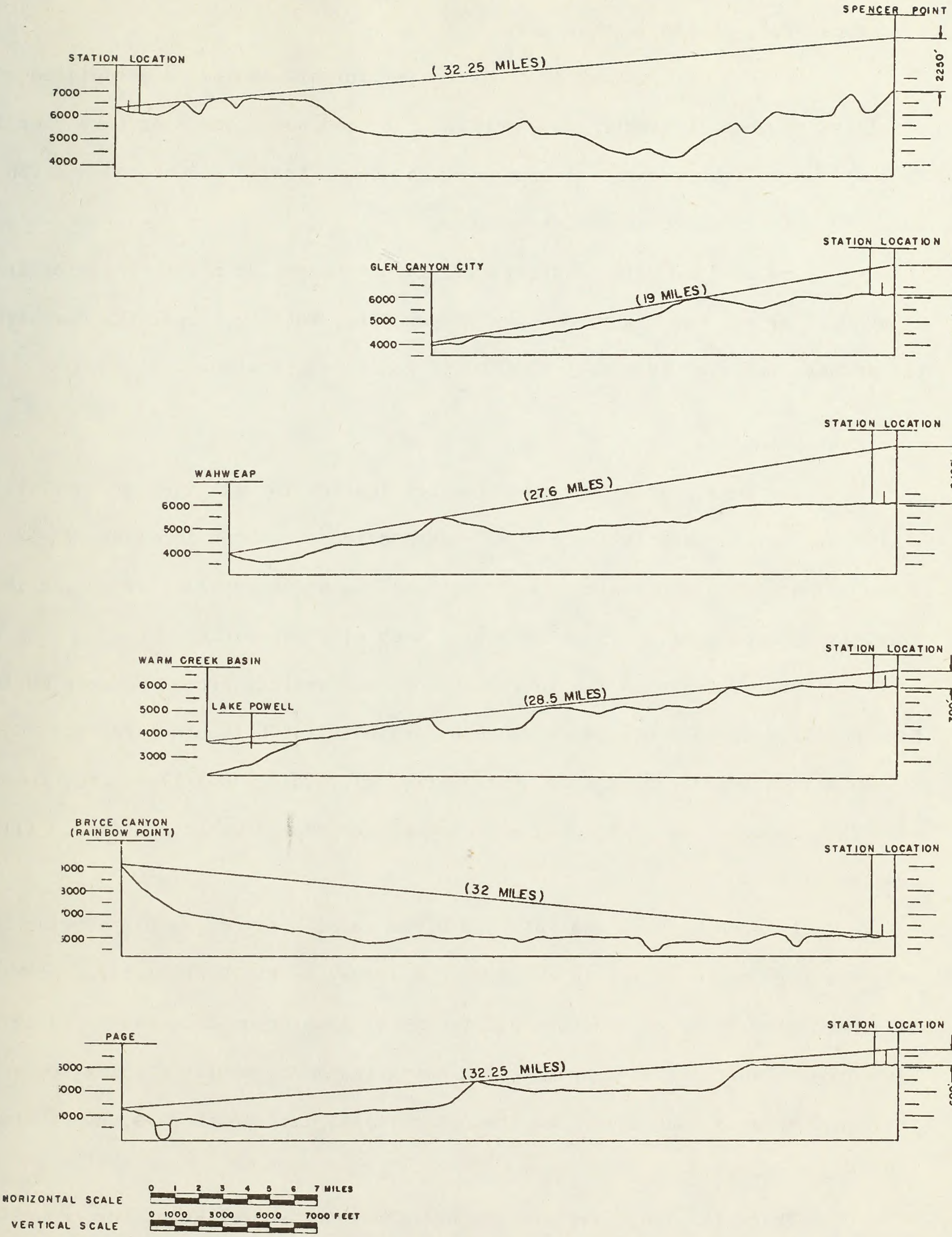


ILLUSTRATION II-51

Scenic Quality


EXCEPTIONAL
EXCELLENT
MODERATE
SLIGHT
SCALE IN MILES
4 3 2 1 0 4 8 12
Canyon
Spring
Trap
Right Hand Collet
Escalante
Paradise
HORSE
MTN
Left Hand Collet
LANDING STRIP
Petes Cove
FIFTY MILE
Rogers
Canyon
Willow
Gulch
Reese
Squaw
Bench
Caine
Bench
Drip Tank
Navajo
BURNING
HILLS
SHIP MTN POINT
6519
Water Canyon
SMOKY
MOUNTAIN
Warm
NIPPLE
BENCH
Nipple Spr.
Alkali Seep
Glen Canyon City
Wiregrass Spr.
Lone Rock Canyon
LAKE
ROMANA MESA
PO
Hollow
R. 2 E.
R. 3 E.
R. 4 E.
R. 5 E.
To Page, Ariz.



ILLUSTR^TION II-52

Line of ͻight Profiles
Key Observation Points to Proposed Plant Site

Rainbow Point in Bryce Canyon National Park and from Spenser Point and other locations along Fiftymile Mountain.

Present noise level in the area is minimal. Noise is associated with airplanes, automobile traffic along Highway 89 and power boats on Lake Powell. There is very light motor bike use along the lower trails and occasional vehicular traffic on the back country roads.

The area is void of artificial light except for night vehicular traffic along U.S. 89 and the lights at Glen Canyon City, Wahweap, Page, the dam site and the strobe lights on stacks of the Navajo generating station.

Recreation use

The impact area is a vacation destination for millions of tourists each year. Visitor use statistics for a 5-year period are shown in Figure II-52 for sites and areas in the region. U.S. Highway 89, which passes through the impact area, is a major tourist route servicing many of these parks.

Most recreation use in the impact area centers around Wahweap Marina on Lake Powell. In 1973 visits at Wahweap totaled 971,800 (Source: Records, Glen Canyon National Recreation Area, Page, Arizona). This was a 27 percent increase over the previous year. Boating and fishing are the major attractions. (Illustration II-53).

Lake Powell and the Colorado River below Glen Canyon Dam provide the only fishing opportunities in the area. A survey by the Utah Division of Wildlife Resources revealed 127,800 angler-days of fishing on Lake Powell in 1972. Warm Creek, Padre and Wahweap bays are among the most popular fishing spots. Principal species caught include channel catfish, largemouth bass, black crappie and rainbow trout.

There is also heavy visitor use along the shoreline of Lake Powell. In 1973 more than 276,000 people visited along the shoreline at primitive and undeveloped sites.

FIGURE II-52

Visitor Days in Kaiparowits Impact Area

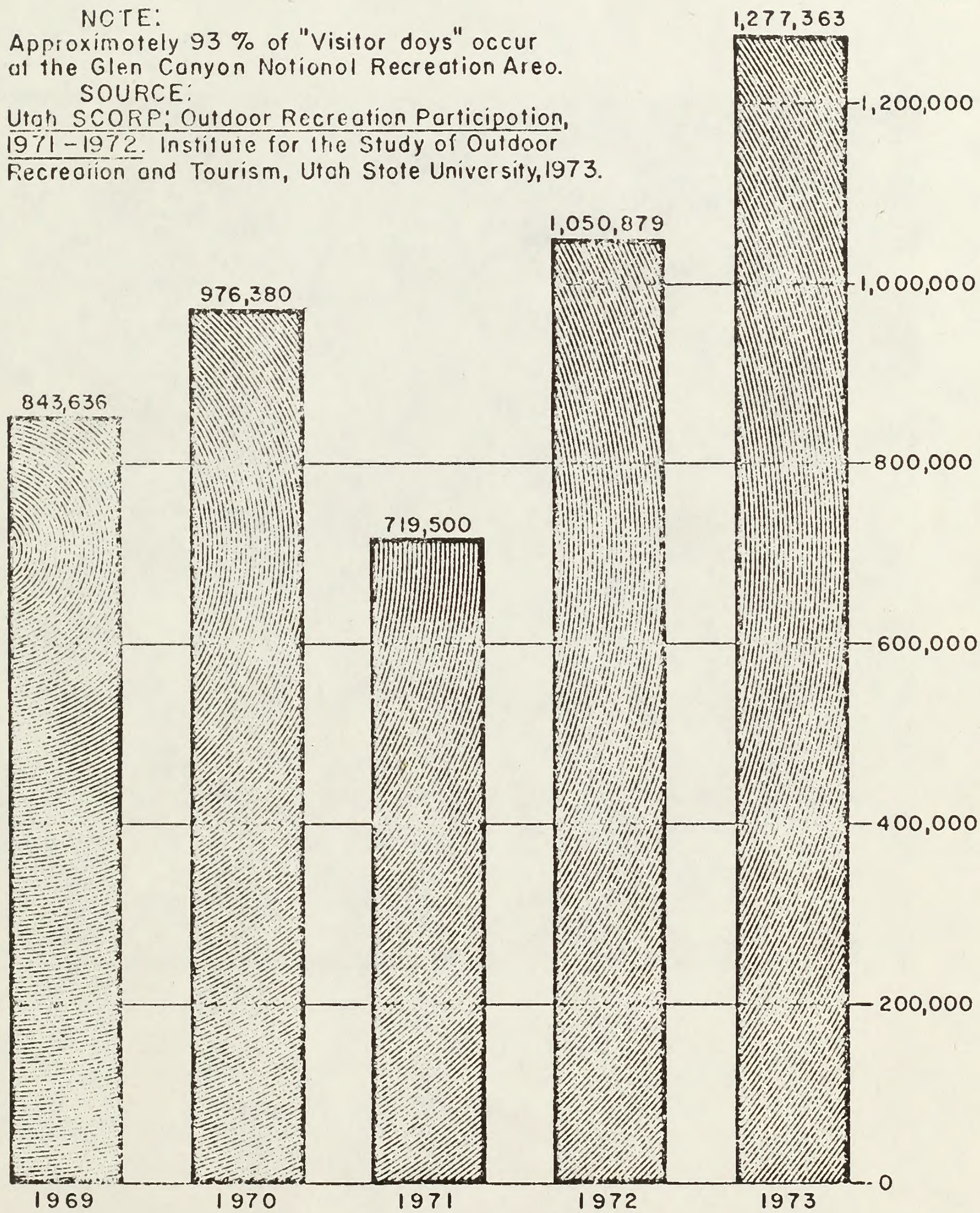


ILLUSTRATION II-53

Wahweap Marina, Lake Powell

Another land-oriented recreation use in the area is hunting. Utah Division of Wildlife Resources found that fewer than 200 big game hunters used the impact area in 1973.

The most popular land-oriented recreational use is back-country exploring. This is done by pickup truck, four-wheel drive vehicles, motorcycles and trail bikes. These activities include sightseeing and camping, and, quite often, rock collecting and viewing of Indian ruins. Related activity is the collection of Indian artifacts.

The lower benches near Glen Canyon City and Lake Powell receive increasingly more use by pickup trucks, four-wheel drive vehicles, motorcycles and trail bikes. No statistics are available, but increasing numbers of tracks through barren shale land and across fragile desert vegetation indicate that this type of use is increasing rapidly.

There is an upward trend in recreation use at most parks and recreation areas in the region (see Figure II-53). An increase of over 300 percent for the period 1970-2000 is predicted for tourist use in the Five-County Region (Figure II-54).

Outdoor recreation facilities within and adjacent to the impact area are shown in Figure II-55.

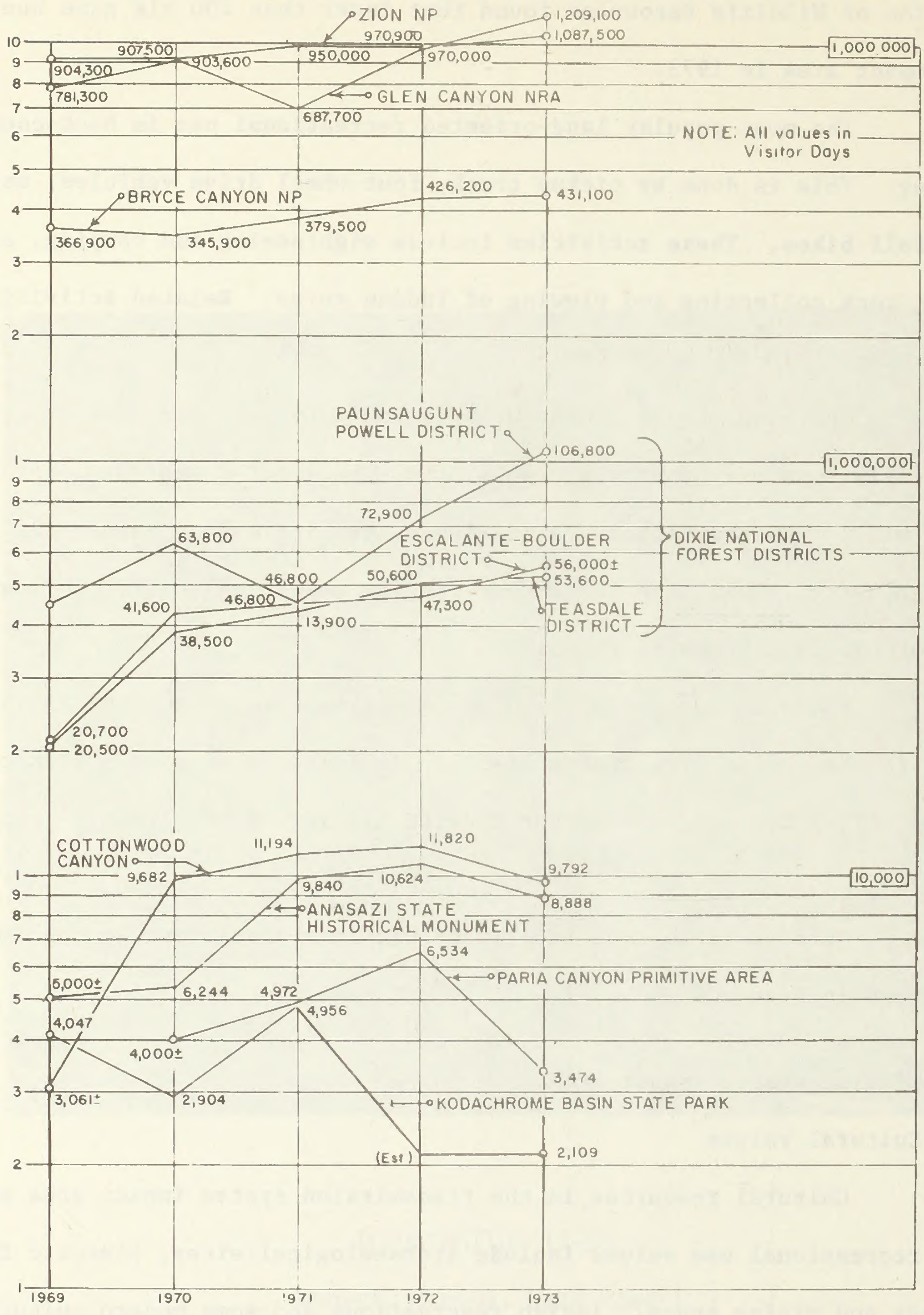
Transmission system impact area

Cultural values

Cultural resources in the transmission system impact area with potential recreational use values include archaeological sites, historic trails, old ranches and mining areas. Indian reservations and some modern cultural developments also have human interest values.

FIGURE II-53

Trends in Visitor Use for Selected Parks and Recreation Areas Within the Region (1969-1973)



SOURCES

1. Bureau of Land Management, 1969-1973, Kanab District Office Files, Kanab Utah.
2. National Park Service, 1969-1973, Public Use of the National Parks, Rocky Mountain Region, N.P.S., Denver, Colorado.
3. Dixie National Forest, 1969-1973, Annual Visitor Use Reports, Cedar City, Utah.
4. Utah Division of Parks and Recreation, December, 1969-January, 1974, Monthly News Letter (Pow-Wow), Salt Lake City, Utah

FIGURE II-54

Nonresident Visitations Actual and Estimated
in Multicounty Planning District 6

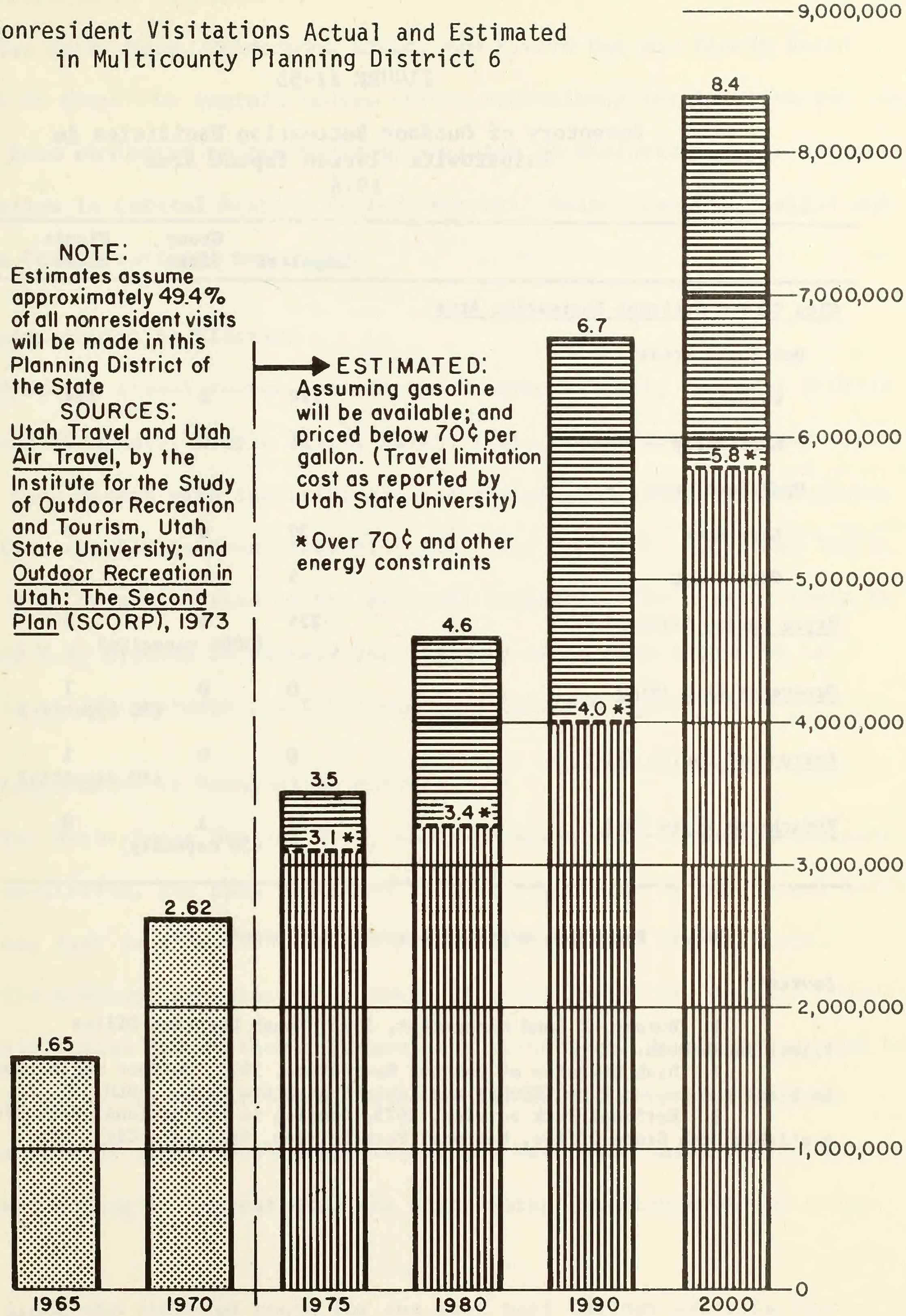


FIGURE II-55

Inventory of Outdoor Recreation Facilities in Kaiparowits Plateau Impact Area 1974

	Campsites	Group Sites	Picnic Sites	Launch Ramps
Glen Canyon National Recreation Area				
Developed Areas				
Wahweap	178	0	124	12 lanes
Lees Ferry	56	0	0	1 lane
Underdeveloped Areas				
Lone Rock	30	0	0	1 lane
Warm Creek	5	0	0	1 lane
Bryce Canyon National Park	225	6 (300+ capacity)	0	0
Grosvenor Arch (BLM)	0	0	1 (30 capacity)	0
Cottonwood Canyon (BLM)	0	0	1 (40 capacity)	0
Kodachrome State Park	22	1 (30 capacity)	0	0

Note: Campsites are also suitable for picnic use.

Sources:

1. Bureau of Land Management, 1973, Kanab District Office Files, Kanab Utah.
2. Utah Division of Outdoor Recreation, 1973, Outdoor Recreation in Utah: the Second Plan (SCORP) available Utah State Office, BLM.
3. National Park Service, 1973, Camping in the National Park System, available Utah State Office, National Park Service, Salt Lake City, Utah.

Kaiparowits to Phoenix

The Perry Mesa, Calderwood Butte, New Rivers Dam and Bloody Basin archaeological districts contain Indian ruins, undeveloped for interpretive use, which have been nominated to the National Register of Historic Places. Significant developed sites in central Arizona include Wupatki, Walnut Canyon, Tuzigot and Montezuma's Castle national monuments.

Kaiparowits to Eldorado

Historic travel routes include the Honeymoon Trail, route of Fathers Dominquez and Escalante, Temple Trail, Navajo Trail and Mormon Immigrant Trail. These have been marked with identifying signs and are interpreted in brochures available from the BLM Arizona Strip District. The Honeymoon Trail and Temple Trail have also been nominated to the National Register. The present Santa Fe Railroad and U.S. Highway 66 closely parallel the wagon road opened by Lt. Edward Beale in 1857 between the Rio Grande and Colorado rivers.

Kaiparowits to Moenkopi to Mohave

The Moqui Stage Station site, about 22 miles west of the participants Moenkopi sub-station, has been nominated as a historic site by the Forest Service. This station, last used in 1890, is not presently developed for visitors.

The Moenkopi sub-station is about 17 miles inside the western boundary of the Navajo Indian Reservation. Hogans, the traditional Navajo homes, can be seen in this area. In recent years, Navajos have received tourist dollars through the sale of traditional craft items, and have also begun a system of tribal parks, adding to recreational and sightseeing importance of the reservation.

Since the proposed route for the most part follows existing transmission line corridors, it avoids populated areas and associated modern cultural resources.

Mohave to Serrano

The plateau region of southern Utah, northern Arizona, and Mohave Desert of southern Nevada and California was apparently only sparsely settled by prehistoric and recent Indian cultures. No known archaeological or historical sites with significant recreational or sightseeing values are expected to be affected by the proposed transmission system in these areas.

The Mohave Desert region also contains such historical features as the Old Government Road, the Santa Fe trail and Camp Young (Patton's Camp), which would be traversed by the Mohave-Serrano segment. Camp Young was used by General Patton from 1942 to 1944 as a desert training and maneuver area, and is still strewn with remnants of military activity.

Northern Kaiparowits to Mohave

The proposed Northern Kaiparowits to Mohave line would follow the alignment of the proposed Kaiparowits to Eldorado Route and then continue southward to Mohave, following an existing 500 kV Southern California Edison line. There are no known sites along the line from Eldorado to Mohave having interpretable recreational values.

Arizona Strip preferred alternate

There are two historic trails along this proposed route: the Navajo Trail, used to raid by and trade with Indians in the St. George Valley, and the Temple Trail, used to haul timber from Mount Trumbull to St. George to build the Mormon Temple. Partial inventories of archaeological resources along this proposed route have not revealed sites which would have interpretable recreational values.

Natural values

The most interesting geologic features in the proposed transmission system impact area include Glen Canyon and Hurricane Cliffs in Utah. The Hurricane Cliffs are one of the longest exposed faults in North America.

Mule deer hunting is one of the most important recreation activities in the mountainous areas crossed by the proposed routes. Ranges in western Arizona, southern Nevada and the California desert support huntable populations of mule deer. See Illustration II-54 for additional information on natural values.

Kaiparowits to Phoenix

Some of the outstanding features along this proposed route include Marble Canyon, Echo Cliffs and portions of the Painted Desert. Further south, the scenic areas are Sycamore Creek, and the Black Canyon and Hell Canyon areas.

Kaiparowits to Eldorado

The Virgin Mountains in northern Arizona, and Lava Butte and Rainbow Gardens in southeastern Nevada are highly scenic and interesting geological features. Other areas having significant visitor appeal are East Kaibab Monocline, known as the Cockscomb, Kanab Creek and the Hurricane Cliffs. Las Vegas Wash and Meadow Valley Wash in southeastern Nevada contain riparian wetland plant communities unlike others in this part of the state. The BLM has designated a stand of Joshua trees in the southwestern corner of Utah as a natural area. Joshua trees are not known to occur elsewhere in Utah. Another such feature crossed by the proposed route is the Sunrise Mountain Natural Area, east of Las Vegas.

Kaiparowits to Moenkopi to Mohave

Coconino Rim, Aubrey and Cottonwood cliffs are outstanding examples of northern Arizona's plateau geology. Cottonwood, Peacock, Black and Hualapai mountain ranges dominate the landscape and offer opportunities for rockhounding, hunting and back-country outings.

The Colorado River and Lake Mead National Recreation Area are popular attractions in the Arizona-Nevada-California border region. Year-round boating, fishing, camping and water sports are enjoyed by hundreds of thousands of recreationists every year.

Mohave to Serrano

The proposed Mohave to Serrano route passes in the vicinity of several interesting and unique geologic formations such as Ward Valley, the Old Woman Mountains, the Coxcomb Mountains and the Eagle Mountains. Erosion in these areas has formed unique land surface patterns.

Northern Kaiparowits to Mohave

The proposed Northern Kaiparowits to Mohave route contains the same natural values as the proposed Kaiparowits to Eldorado segment, with the exception of 58 miles between Eldorado and Mohave. Along this link the Highland Mountain Range offers unique scenic values and supports bighorn sheep.

Arizona Strip preferred alternate

Much of the area through the Virgin Mountains is pristine wildlife habitat. Major recreational activities are hunting and back-country use. The Virgin Mountains are crucial summer and winter range for mule deer. There is a designated natural area in the Nevada portion and a designated primitive area in the Arizona portion.

Primitive wilderness

Primitive values along the proposed transmission routes were considered not only for officially-designated primitive or wilderness areas, but for areas which are essentially roadless, uninhabited or otherwise generally do not show permanent effects of civilization. See Illustration II-54 for additional information.

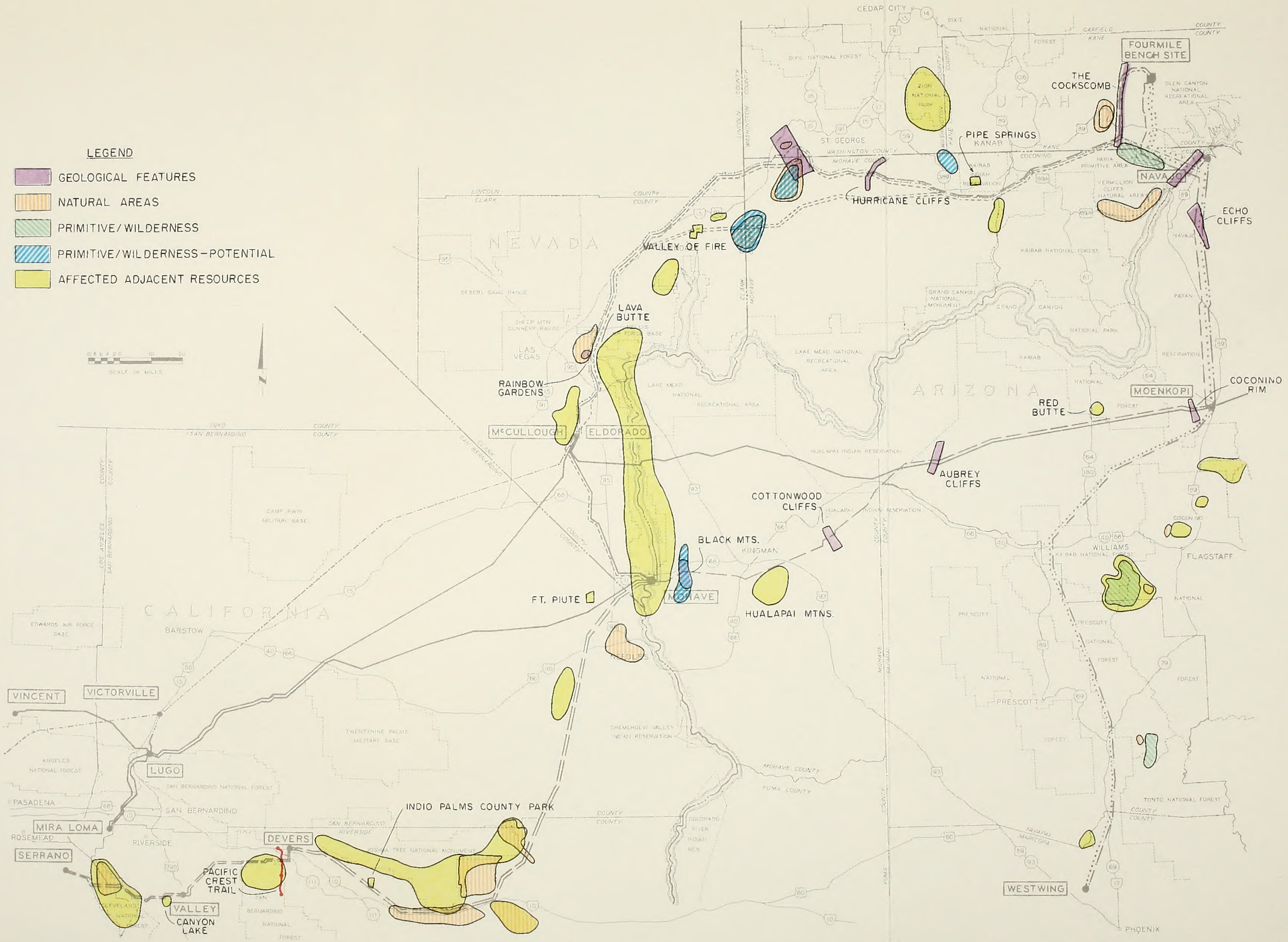


ILLUSTRATION II-54

Recreational Resources

Kaiparowits to Phoenix

There are no wilderness or primitive areas in this proposed corridor, though Sycamore Canyon and Pine Mountain are approximately 10 miles distant.

Kaiparowits to Eldorado

Arrow Canyon and the McCullough Mountains just north of the proposed route include large areas of prime desert bighorn habitat. Existence of this species depends on the preservation of undisturbed desert mountain country. The proposed route also passes near the Buckskin entrance to Paria Canyon Primitive Area (BLM), and through the northern portion of a potential primitive area on Kanab Creek.

Kaiparowits to Moenkopi to Mohave

The proposed Kaiparowits to Moenkopi to Mohave route, which would pass through foothills of the Cottonwood Mountains.south of Peach Springs, Arizona, would cross about 25 miles of undisturbed natural landscape. This is the only portion that would pass through a remote area not having existing transmission lines or utility corridors.

The proposed route passes through portions of western Arizona's Black Mountain Range. Primitive values are found both to the north and south of the Secret Pass crossing. This area has outstanding scenery, known archaeological sites and desert bighorn sheep. An existing utility corridor in the pass detracts from the natural beauty of the area.

Mohave to Serrano

The proposed Mohave to Serrano line segment passes through BLM-designated recreation lands in California, with identified primitive values including the candidate Sacramento Natural Area and the Old Woman, Turtle, Coxcomb and Eagle mountains. These highly scenic, rugged, desert ranges possess excellent

opportunities for unconfined recreation in a natural setting. These areas are also popular rockhounding sites once inhabited by desert bighorn sheep.

The route would also pass through Orocopia and Chuckwalla candidate natural areas. These areas include outstanding geological formations, desert wildlife, and extensive natural areas. The proposed route traverses the Santa Ana Mountains of the Cleveland National Forest near the Bald Peak-Silverado Canyon area. Much of this area has been proposed for roadless designation. Coldwater and Horsethief riding and hiking trails traverse Santa Ana Range, which has relatively undisturbed natural values.

Northern Kaiparowits to Mohave

Primitive values in this proposed segment are the same as along the Kaiparowits to Eldorado line, with the addition of 58 miles from Eldorado to Mohave. Along this route the Highland Mountain Range has been identified as a potential primitive area. Peaks and eastern side of this range are bighorn sheep habitat.

Arizona Strip preferred alternate

The proposed Arizona Strip preferred alternate route passes through the Virgin River Recreation Lands established in 1970 for the protection of interesting, rare and unusual plants and animals. The transmission line would also pass between two primitive areas, north of the Nevada portion of the Virgin Mountains Primitive Area and south of the Arizona portion. The route would pass within 6 miles of the Paiute Primitive Area (Arizona BLM) and within 4 miles of the Virgin Mountains Natural Area (Nevada BLM). The proposed route also goes through prime hunting areas in the Black Rock Mountains.

Recreation uses

In Utah, Nevada and Arizona the proposed transmission lines would usually occupy lands far removed from major urban centers. These remote areas

receive only limited recreational use, although opportunities and varieties are abundant. Where the routes cross lands nearer to Las Vegas (Nevada), Phoenix (Arizona) and in California, many of the same recreational opportunities and varieties exist, but they are used much more intensively because of population pressures and easier access to both developed and undeveloped recreation sites (Illustration II-54).

Kaiparowits to Phoenix

The proposed Kaiparowits to Phoenix segment would cross the following recreation-access and scenic highways: Arizona 64 and 180, I-40 and I-17. Recreation areas in the vicinity include Kaibab National Forest, Coconino National Forest, Prescott National Forest, Black Canyon Trail System, Grand Canyon, Horsethief Basin and Lake, Mingus Mountains, Lynx Lake, Sunset Point, Paria Townsite, Castle Hot Springs, Granite Lake, Colorado River, Little Colorado River, Verde River, Sycamore Canyon Wilderness Area, Pine Mountain Wilderness Area, Glen Canyon Dam, Kodachrome Flats, Lake Powell, the Fiftymile Mountain roadless area, Painted Desert and Marble Canyon.

Kaiparowits to Navajo

Recreation access Highway U.S. 89 would be crossed by this proposed segment. Recreation areas in the vicinity of this short segment include Paria Canyon Primitive Area and Glen Canyon National Recreation Area.

Kaiparowits to Eldorado

The proposed Kaiparowits to Eldorado line would cross the following recreation access and scenic highways: I-15, U.S. 89, 89A, U.S. 91, U.S. 93, Nevada Highways 7 and 41. Recreation areas in the vicinity include Sunrise Mountain Natural Area, Rainbow Gardens, Las Vegas Wash, Las Vegas Dunes Recreation

Area, Paria Canyon Primitive Area, Lake Mead Recreation Area, and Valley of Fire State Park.

Kaiparowits to Moenkopi to Mohave

Arizona Highway 64 (six million users annually) would be crossed by this proposed line. Recreation areas in the vicinity include Lower Colorado River, Grand Canyon, Lake Mead Recreation Area, Black Mountains, Secret Pass, Coconino Rim, Aubrey Cliffs, Hackberry Canyon, and the Cottonwood Cliffs.

Mohave to Serrano

The proposed Mohave to Serrano line would cross the following recreation access and scenic highways: I-40 and I-10, California Highways 111, 62, and 243, and the proposed Weir Canyon Road. Recreation areas in the vicinity include Joshua Tree National Monument, Lower Colorado River, Mecca Hills Off-Road Vehicle (ORV) Area, Eagle Mountain ORV Area, Indio Hills ORV Area, Danby Dry Lake ORV Area, Indio Palms County Park, Thousand Palms Oasis, Old Woman Mountains, Turtle Mountain, Chuckwalla Mountains, Eagle Mountain Range, Orocopia, Cleveland National Forest, Coldwater and Horsethief riding and hiking trails, Pushwalla Canyon, Canyon Lake, Perris Lake, Elsinore Lake, Glen Ivy Recreation Vehicle Park, Irvine and Villa Park Dam county parks, Pacific Crest Trail, the Piute Mountains, and the Orange County proposed Upper Silverado and Limestone-Santiago county parks.

Northern Kaiparowits to Mohave preferred alternate

The proposed Northern preferred alternate line would follow the Kaiparowits to Eldorado route, then extend to the Mohave generating station. Additional recreation access highways crossed are Nevada Highways 68 and 77 and U.S. 95. Recreation areas in the vicinity are Lake Mohave and the Highland Mountain Range.

Arizona Strip preferred alternate

The proposed Arizona Strip preferred alternate route leaves the Kaiparowits to Eldorado route near Pipe Springs National Monument and returns to that route west of Glendale, Nevada. Recreation access route Nevada Highway 12 is crossed and recreation areas in the vicinity are the Virgin Mountains and the Virgin River Recreation Lands.

Aesthetics

Scenic quality evaluations (high, medium, low) are made for areas along the proposed transmission system routes, as shown in Illustration II-55. Criteria for the relative ratings include variety and visual sensitivity.

"High" ratings are assigned areas where landforms, vegetation patterns, water forms and rock formations are of unusual, outstanding or distinctive visual quality.

"Medium" refers to those areas having some variety in form, color, line, and texture, but which tend to be common in visual quality.

"Low" refers to those areas having little variety, tending to appear monotonous or depressing to the viewer.

Development

The proposed transmission line would not cross public or commercial recreation developments. Illustrations II-54 and II-55 show the known recreation areas which might be impacted by construction, operation or maintenance of the proposed transmission system.

Affected adjacent resources

Although no established recreation developments are actually crossed by the proposed system, there are numerous sites, parks and large expanses of recreation lands adjacent to or within critical distance of the corridors. In addition,

the BLM and the Forest Service have inventoried several adjacent areas containing valuable outdoor recreation potential. They plan to manage these lands for outdoor recreation. See Illustration II-55 for additional resource information.

Limestone quarry impact area

The primary recreation value in the area is the scenic value of the colorful ridges as viewed from the Johns Valley road. The scenic values are rated as "moderate" and the visual vulnerability of the mine site is "low" (the mine site is not visible from the Johns Valley road). Natural values in the area are limited.

Deer, elk and sage grouse are occasionally sighted in the area. The Utah prairie dog which is a rare species but fairly common in this area can be viewed. The area is interlaced with roads and other evidences of human use and occupation so the primitive values are negligible.

There are no known historic or archaeological sites on the area which have significant recreation value.

Recreation use in the area is minimal. Hunting is the major activity. There are from 10 to 20 visitor-days of use, mostly during the fall. In addition to hunting, recreation uses include "pinenut" gathering, and use by livestock men, sightseers and firewood gatherers.

The general area (not the mine site) is visible from the Johns Valley road, which has an average daily traffic count of 110 (Traffic on Utah Highways, 1973). About 20 percent of this traffic is out-of-state, suggesting that tourists are using this road as a short cut from U-24 to Bryce Canyon National Park and back. Assuming that 15 percent of the traffic is for recreation, with an average vehicle occupancy rate of 3.2, approximately 193,000 recreationists pass the impact area annually.

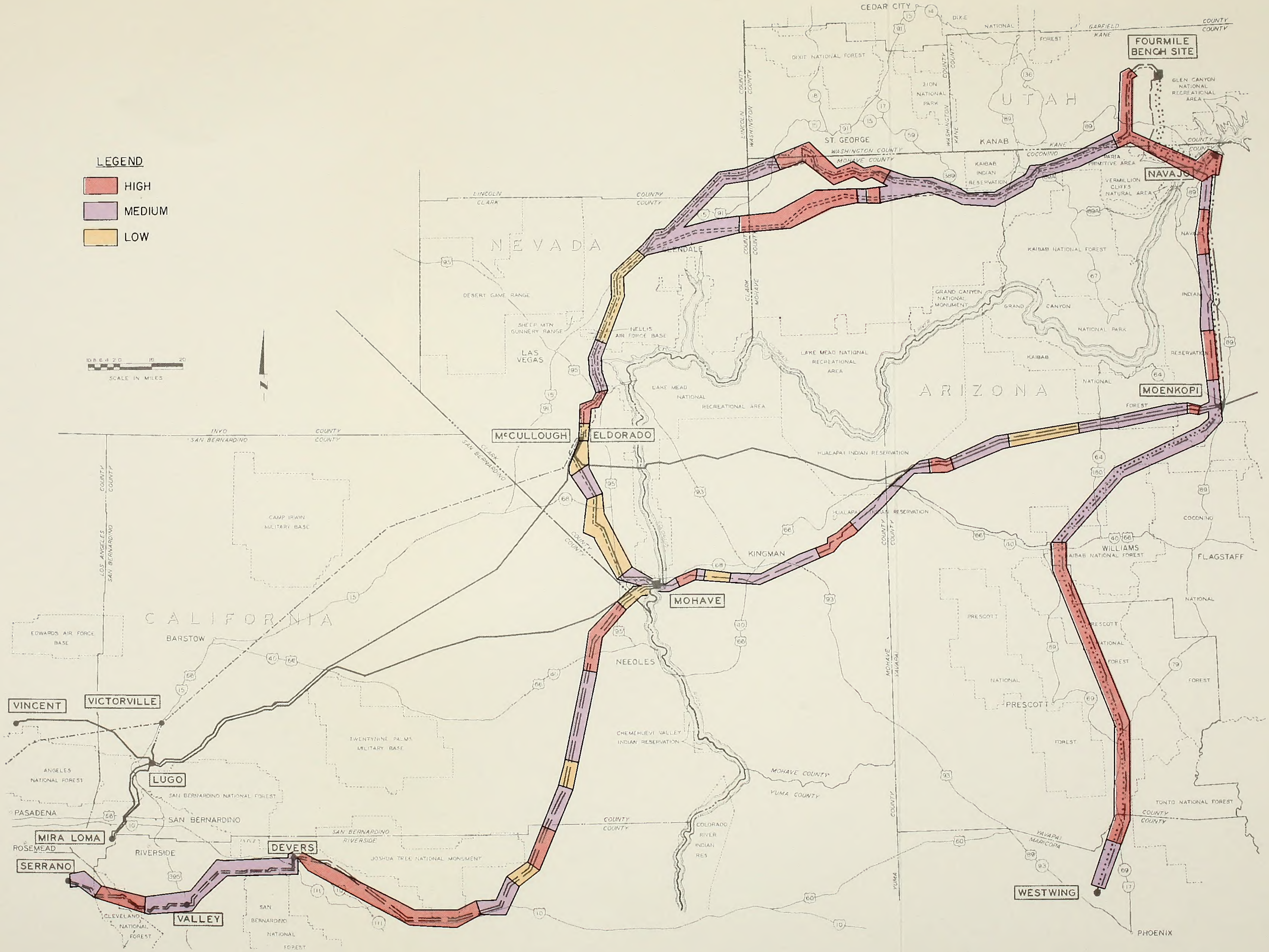


ILLUSTRATION II-55

Aesthetics - Scenic Quality

Land use

Kaiparowits Plateau impact area

Introduction

About 88 percent of Kane and Garfield counties is public land administered by the Bureau of Land Management (BLM), Forest Service and National Park Service (Socioeconomic Data System, BLM). About 7.5 percent is under state administration, and the remaining 4.7 percent is private. Because of the overlap of several kinds of land use in both counties, the land can be described as "multiple use." Much of the federal land is used for seasonal grazing by 40,000 to 50,000 head of cattle and sheep. Wood products are harvested, mostly from federal lands; about 99 percent of timber sales are from Dixie National Forest. About 1 percent of the area is privately owned crop and pasture land, and a total of only 0.06 percent is occupied by the communities of the two counties. Recreation is very important in both counties and is a significant land use throughout the public areas. Industrial activities are relatively minor.

The following describes current land uses, inviting attention to the area in which each use is most likely to be affected. For instance, grazing is apt to be most affected in the area of the immediate proposed project, whereas the need for mineral resources may require mining a much larger area.

Livestock grazing

The proposed Fourmile Bench plant site is in a pasture of the Headwaters Allotment. Seven licensees have 148 head of cattle in the pasture from November 1 to March 31.

These licensees keep their cattle on private property from April to October. From May 1 until September 30 their cattle are either grazing on the summer portion of the Headwaters Allotment or on national forest land. All pastures in the Headwaters Allotment are stocked to capacity.

The proposed coal mine and associated facilities are in the northern portion of Upper Warm Creek Allotment. Three licensees graze 221 head of cattle in this allotment from November 1 to May 31.

The Upper Warm Creek Allotment is stocked to capacity. Grazing privileges mentioned above are a key part of year-round cattle operations.

The proposed East Clark Bench townsite covers portions of three BLM livestock grazing allotments. Nine operators are authorized to graze about 5,766 animal unit months on the three allotments. All operations involve cattle. Two allotments are grazed during the winter and early spring, and the third is grazed winter-summer. All operations except one are under rest-rotation grazing systems. Present capacity of the townsite is about 20 acres per animal unit month. Range improvements in the proposed townsite include a well and fences.

Mineral development

Present mineral production comes from the Upper Valley oil field near Escalante, which has produced more than 12 million barrels of oil since commercial production started in 1964, and perhaps a dozen active or intermittent sand and gravel pits near Glen Canyon City, Escalante and Henrieville. Sand and gravel production is variable from year to year, due mainly to variable highway maintenance and other construction schedules. Estimated annual production average is 12,000 cubic yards. However, it has been as high as a million cubic yards during times of heavy construction (e.g., Glen Canyon Dam and the Navajo power plant). Past mineral activity and potential mineral values are discussed under economic geology in the geology-topography section.

Wood products

Only about a quarter of the Kaiparowits impact area is woodland. Most of this is in the northern part and is predominantly pinyon-juniper. These species and their general quality have so far not encouraged commercial wood

production. A few local ranchers annually obtain permits to cut juniper fence posts, but usually no more than 200 posts are cut a year. Most of these are taken in the Fourmile Bench-Horse Mountain area.

Agriculture

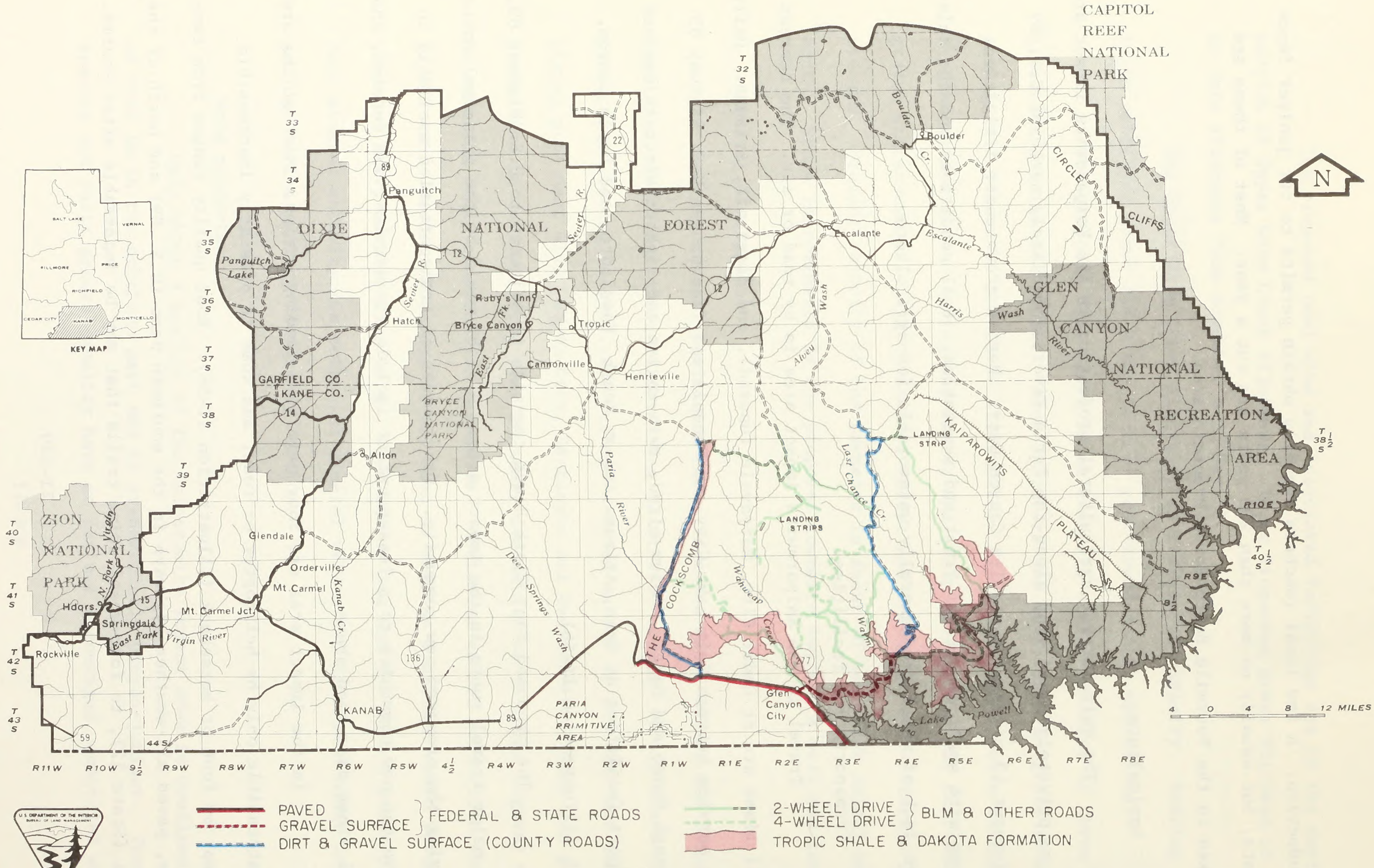
The only current agricultural production in the Kaiparowits impact area is on privately-owned land along the Paria River, immediately north of U.S. 89 and about 13 miles west of Glen Canyon City. Hay is grown under irrigation, along with small amounts of fruit and vegetables. Soil conditions and the relative lack of water are generally unfavorable for agriculture.

Transportation facilities

Travel to the Kaiparowits impact area is by road or air. The nearest rail lines are at Cedar City, Marysvale (unused), and Flagstaff, Arizona. Daily bus service between Salt Lake City and Phoenix and Tucson uses U.S. Highway 89 through Kanab and Page. Medium-sized, twin-engine and lighter aircraft can use airport facilities at Page, Arizona and at Kanab, Escalante, and Bryce Canyon, Utah (Illustration II-56).

The proposed East Clark Bench townsite is adjacent to U.S. Highway 89, the major travel route in the impact area. U.S. 89 would be the principal route serving the proposed new community. Other modes of transportation available to serve the new community to a lesser extent include air service, bus service, and rail lines discussed above.

In the impact area are four primitive landing strips. Most of the area is accessible only by helicopter or road, and some is presently inaccessible except by foot or horseback (Illustration II-56). Road quality ranges from two-lane, paved all-weather highways in the southern part (U.S. 89) and north of the area (State 12), to four-wheel drive trails that may be impassable after storms.



KANAB DISTRICT
1974
UTAH

ILLUSTRATION II-56

Land Use - Transportation

More than 2,000 miles of roads and highways in Kane and Garfield counties are administered by federal, state, and county governments. Figure II-56 shows approximate mileage of roads in the Kaiparowits impact area only. Density of roads is high, with an average of about a mile of road or trail to 3 square miles of surface area. Roads in the plateau impact area are either gravel-surfaced or unimproved. They are used for recreation, by grazing licensees, and for BLM administration. They provide access between such points as Cannonville and Glen Canyon City, Escalante and Glen Canyon City, Escalante and Lake Powell, and various places in the area.

Light road usage in the impact area has not justified major road construction and the routes chosen use topographic advantages. The nature of the terrain is such that roads must cross a variety of ground. As a result, it is sometimes necessary to travel a considerably greater distance than the direct distance between two places.

Most roads are in major canyons, to some point where access can be gained to high ground, such as at the head of the canyon. The roads then cross benches and ridges, except at impassable points where they either end or are routed into the canyons again. Large sections of road are frequently washed out by floods. Shelf roads built into the faces of cliffs are also exposed to such hazards as washouts and landslides. Roads on the upper benches and ridges may be bumpy in places and are likely to be covered with wind blown sand, but they are generally smoother and more easily maintained than shelf roads and those in canyons.

Tropic shale (Illustration II-56) creates a problem for road construction and maintenance. Roads built on the shale must be gravel-surfaced in order to remain usable; however, the gravel tends to sink into the shale, mix with it, and lose its effectiveness. Additional layers of gravel must be spread on these roads frequently.

FIGURE II-56

Mileage and Categories of Roads in the Kaiparowits Plateau Impact Area

Responsible Authority	Category	Surface	Mileage[a]	
			Traversible by 2-wheel drive	Traversible by 4-wheel drive
U.S. State (No. 89)	-	paved	25	-
County	-	dirt and gravel	73	-
County, BLM	-	dirt and gravel	22	-
BLM	[b]M-1	dirt and gravel	67	11
BLM	M-2	dirt and gravel	46	39
BLM	M-3	dirt and gravel	29	21
BLM	M-4	dirt and gravel	46	56
BLM	M-5	dirt and gravel	-	11
Total			308	138

[a]Figures are approximate; several miles of four-wheel drive trails are not included.

[b]Indicates maintenance schedule: M-1 - maintained yearly; M-2 - maintained every other year; M-3 - maintained every 3 years, etc. This provides a rough measure of use, as roads are maintained on the basis of need.

Source: Bureau of Land Management, Kanab District Transportation Plan (revised, February 15, 1973).

Fourmile Bench is accessible from Cannonville by a dirt road across the north end of the Cockscomb, near Grosvenor Arch; from U.S. 89, at a point about 10 miles west of Glen Canyon City, via Cottonwood Canyon to the Cannonville-Fourmile Bench road; and from Glen Canyon City, either along the Warm Creek road or Kelly Grade to the Smoky Mountain road, then along Last Chance and Paradise Canyons. Much of the proposed mining area, between Fourmile Bench and Smoky Mountain, is accessible only by the Head of Creeks road. Parts of this road are passable only with four-wheel drive capability.

Transmission system impact area

Most of the land involved is open, undeveloped range land. However, two of the routes in Arizona and California terminate at electric distribution substations in or close to large urban areas: within city limits of Orange, California, and in northwest Maricopa County, on the outskirts of Phoenix, Arizona. The route also passes 10 miles southeast of Las Vegas, Nevada. Otherwise, in Utah, Nevada, Arizona, and the eastern portion of California, the routes occasionally pass near small communities and developing areas with populations from 25 to 10,000 (Illustration II-57).

Livestock grazing (mainly cattle), and open-space recreation, (e.g., sightseeing, hunting and off-road vehicle driving) are the main land uses along the routes in Utah, Nevada, and Arizona. Open-space recreation is the prime use along the routes in California. Roads and highways, natural gas pipelines, major electric transmission lines, and railroad lines are crossed by the proposed routes in all four of the states. These will be discussed below under transportation facilities. Also refer to Illustration II-58 for specific map locations of the transportation arteries.

Forty-one communication sites are proposed: 32 exist, of which 16 would be modified or expanded, and nine new sites would be developed. These would

accommodate the monitoring system for the proposed new Kaiparowits lines. All these sites would occupy high-elevation areas.

Livestock grazing

Cattle and some sheep graze along the proposed routes in Utah, Nevada and Arizona, on federal, state and private lands. Indian lands in Arizona are grazed mostly by sheep and goats, with some cattle. In California, on federal, state, private and Morongo Indian lands, limited domestic livestock grazing is carried on. The availability of livestock forage is uncertain over most of the proposed California route from the Mohave generating station to the Devers substation (eastern and central California route) due to climatic conditions.

Forage production is dependent on precipitation. Much of the forage in these areas, when available, is annual grasses, weeds and flowers.

From the Devers to the Serrano substations (western California route) cattle are grazed on private land for milk and beef production. This area has more favorable climate and vegetation for livestock grazing than other areas along the proposed routes.

Federal lands in these four states are licensed or leased to local livestock operators, based on the carrying capacity of the land by the BLM for national resource lands, the Forest Service for national forest land and cooperative agreement between the BLM and the Park Service on national park lands in the Glen Canyon and Lake Mead National Recreation areas.

State lands are leased to private livestock operators and private lands are frequently used by them. Indian reservation grazing lands are reserved for Indian use.

All suitable lands are usually grazed year-round, depending on forage availability and water, except dry desert portions of southern Nevada and eastern and central California. These are grazed only when vegetation is available.

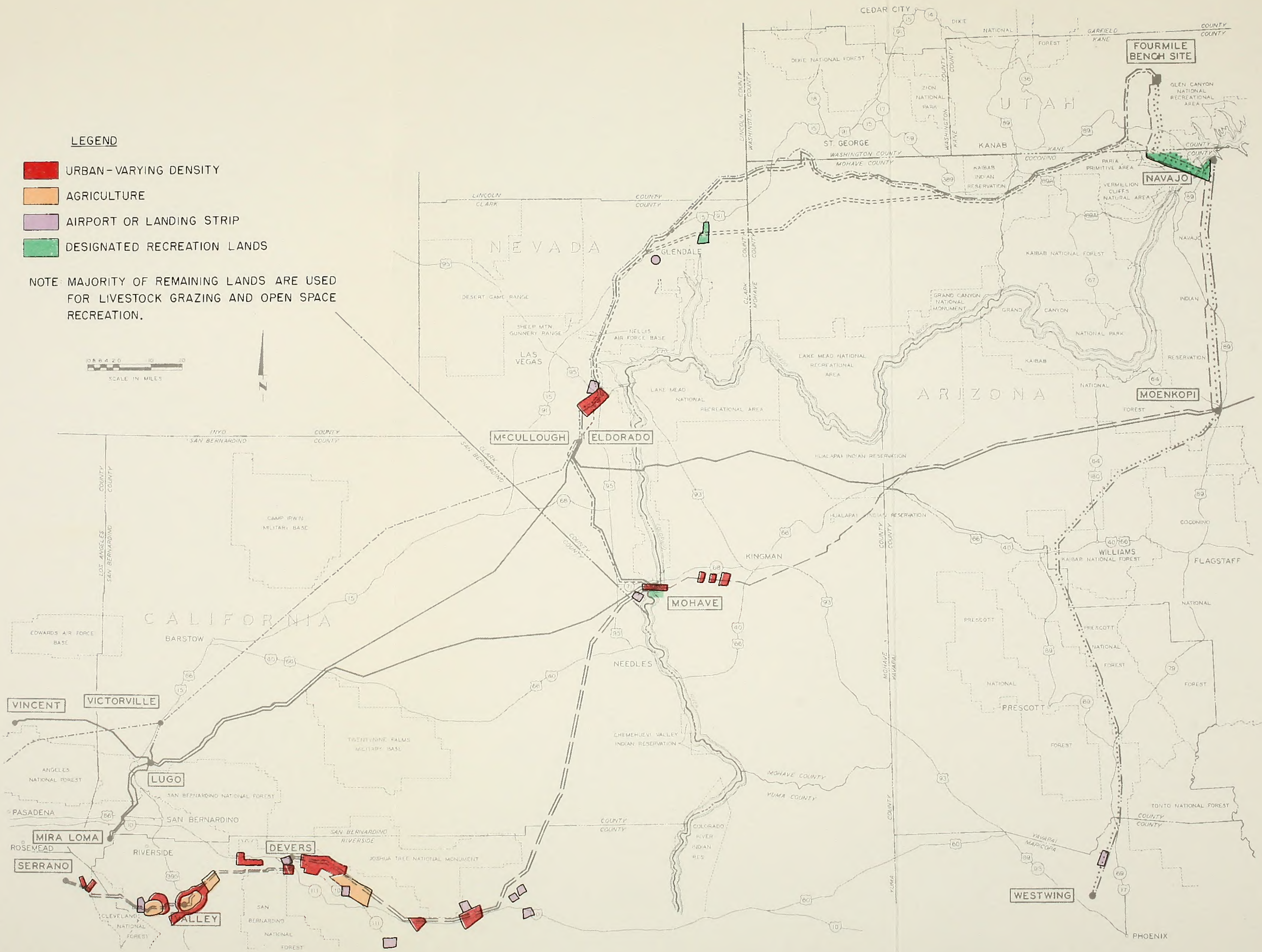


ILLUSTRATION II-57

Land Uses

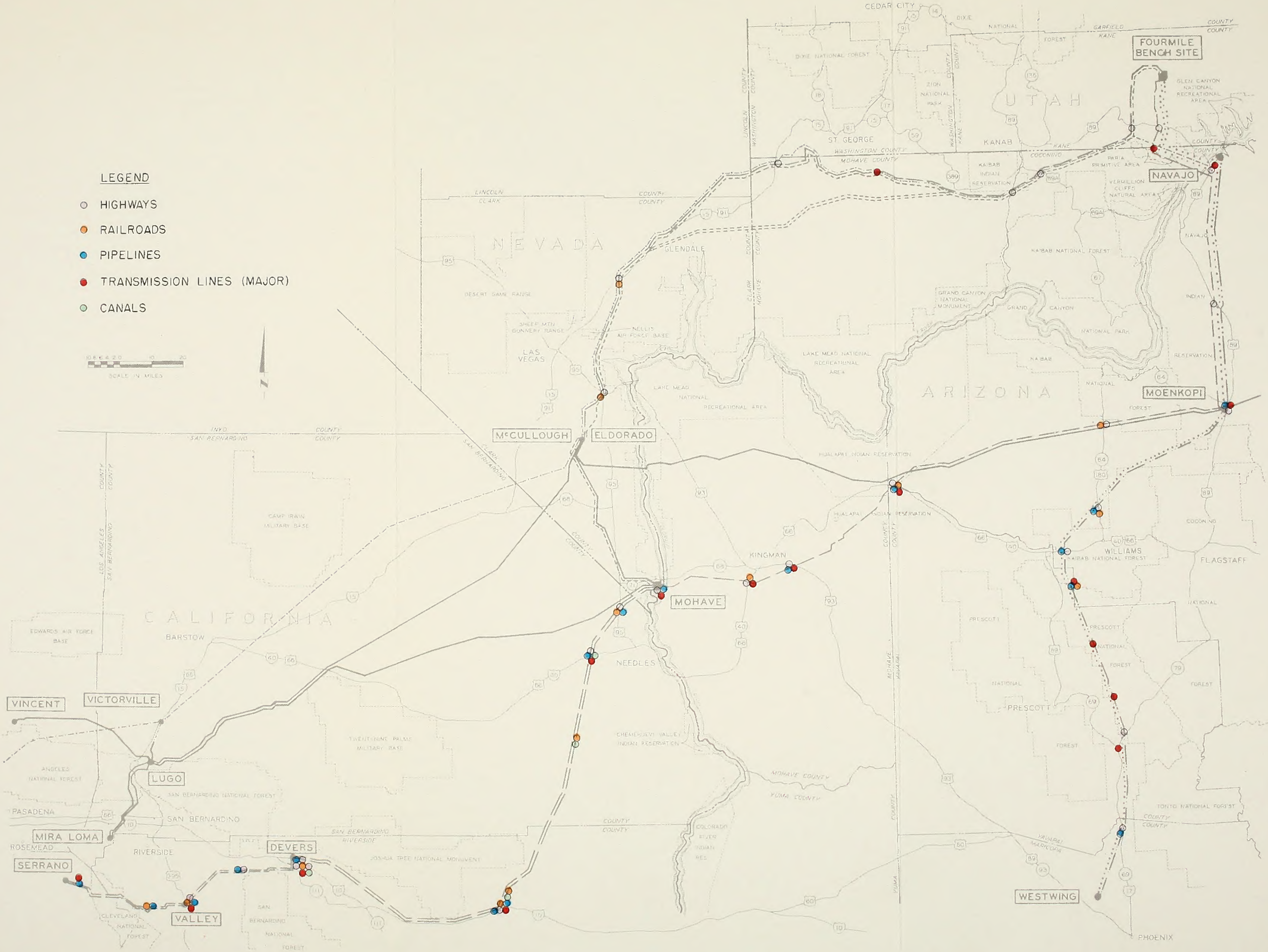


ILLUSTRATION II-58

Transportation Facilities - Intersections

Ephemeral vegetation is dependent on rainfall and corresponding seed germination which usually occurs once every 3 or 4 years in the Mohave Desert.

Mineral development

No mineral development operations are crossed by any of the proposed routes, including aggregate sites. The proposed routes cross many old prospect and mining claims, primarily gold and silver in California and Nevada, and gold, silver, copper, and iron ore in Arizona and Utah. Aggregate deposits are plentiful along the California route as well as on other lands in the area. Aggregate deposits are known on the central (Prescott to Phoenix) and western Arizona routes (Kingman to Bullhead City), and the Nevada segment.

Some of the lands near the proposed Kaiparowits plant site are currently under coal lease.

Kaiparowits to Eldorado

In southern Nevada, northeast of Las Vegas, Simplot Company operates two plants and three open pits for mining and processing silica sand, within 2 miles of the proposed Kaiparowits to Eldorado corridor.

Mohave to Serrano

In eastern California the proposed route crosses Danby Lake saline deposits (solar evaporation of sodium sulphate). These deposits are not being mined; the evaporation ponds are approximately 4 miles from the proposed Mohave to Serrano corridor.

In western California, operations within 5 miles of the proposed route include the Eagle Mountain iron mine and several clay mines, most of them east of Cleveland National Forest.

Some lands along the proposed California route may be valuable for oil and gas, but no known exploration activities are under way.

Wood products

There are no major wood products sales along the proposed routes. However, the Forest Service and the BLM periodically issue small sales contracts (under $500) for firewood, fence posts, and Christmas trees on federal lands. Private land owners harvest limited quantities of firewood and fence posts for personal needs.

Agriculture

The proposed routes do not cross agricultural lands except for 29 miles in western California. Lands in the immediate area of the proposed route in the Moapa Valley near Glendale, Nevada produce some vegetables for shipment to nearby Las Vegas. Also some grain and forage crops are produced for feeding local dairy and beef cattle.

In the western portion of the Mohave to Serrano route, citrus fruits and dates are grown in the Indio area of the Coachella Valley. The most extensive agricultural production along the proposed route occurs in the San Jacinto and Menifee Valleys where sugar beets, grain, citrus and other fruits, and a variety of vegetables are grown. The area north of Elsinore in the Temescal Valley produces citrus fruit and some avocados (Illustration II-57).

Transportation facilities

The proposed routes cross numerous major and minor electric transmission lines, natural gas pipelines, telephone lines, water pipelines, canals, the Colorado River, airports, airstrips, highways of various types and sizes, roads, railroads and a coal-slurry pipeline. The respective locations of these facilities are shown on Illustration II-58.

Larger urban areas near the routes have complete transportation facilities, including major airlines, railroads and interstate highways for commerce, marketing and personal use.

Smaller communities near the proposed routes have fewer transportation facilities. These communities are serviced by the intrastate highway system and highways connecting with the interstate system. Rail transportation is available only to the California communities and Kingman and Flagstaff, Arizona. Remaining communities have no rail access. Medium-size communities are served by smaller feeder-line airlines with passenger and some freight service. The smaller communities are serviced by highway only.

The proposed Kaiparowits to Eldorado transmission route would cross a variety of roadways from county gravel roads to Interstate Highway 15. There are also numerous less-traveled back country roads in the immediate area of the proposed route. Many of these roads would probably be used as access for construction and maintenance of the line.

This proposed route also crosses the main line of the Union Pacific Railroad at two points in Nevada. This line connects Salt Lake City and Los Angeles.

The proposed transmission line would cross or parallel several other electric transmission or communication lines of varying size, including both overhead construction and buried cable. These are shown on Illustration II-58.

In summary, this route would cross eight highways, three railroad tracks, three telephone lines and five electric transmission lines.

The Eldorado to Mohave portions of both the Northern Kaiparowits to Mohave preferred alternate, and Arizona Strip preferred alternate would additionally cross: three highways, a natural gas line, two telephone lines and two electric transmission lines.

The Arizona Strip preferred alternate would cross one less highway than the Northern Kaiparowits to Mohave preferred alternate.

The Kaiparowits to Phoenix, Kaiparowits to Navajo and Kaiparowits to Moenkopi to Mohave proposed routes cross numerous roadways, some of which receive

up to six million users annually. Also crossed is the Mohave coal slurry pipeline which connects with the Peabody Coal Mine in northeast Arizona, and the Mohave generating plant in southern Nevada, in the Lower Colorado River area.

In central Arizona the route crosses two interstate natural gas pipelines 30 miles west of Williams. Fifteen miles south of Phoenix the proposed route crosses the Lake Pleasant landing strip approach, a mile south of Lake Pleasant, a water-sport recreation spot for southern Arizona.

The central-west Arizona route (Moenkopi-Mohave) crosses Interstate 40 in two locations. This route also crosses Santa Fe Railroad tracks in three areas, all near Kingman, Arizona.

In summary, the proposed route crosses the following number of transportation facilities:

Northeast Arizona - (Kaiparowits to Moenkopi and Kaiparowits to Navajo)

- 4 highways
- 3 transmission lines

Central Arizona - (Moenkopi to Mohave Plant)

- 5 highways
- 3 railroad tracks
- 3 telephone lines
- 5 electric transmission lines

Central Arizona to Southern Arizona - (Moenkopi to Phoenix)

- 11 highways
- 5 railroad tracks
- 8 telephone lines
- 9 electric transmission lines
- 6 natural gas lines

In California (Mohave to Serrano), a number of transportation corridors are either crossed by or are adjacent to the proposed route. Many minor roads,

mostly unsurfaced, would also be crossed by the proposed route throughout its length.

Crossings would occur on Interstate routes 10 and 40, primary highways throughout the Southwest, and on U.S. 395, primary north-south highway through California, Oregon and Washington. Also to be crossed would be the Atchison, Topeka, and Santa Fe Railroad (ATSF) near Goffs and Danby Dry Lake, and the Southern Pacific south of the Devers substation. The ATSF spur lines would also be crossed near Romoland and Elsinore.

The proposed route passes airports or airstrips from Mohave generating plant to Serrano substation as follows:

Airport	Approximate Distance From Proposed Route (ft)
Bullhead City	13,700
Desert Center	36,500
Kaiser Airpark	9,800
M.W.D. Private	4,300
Shavers Summit	1,700
Thermal	41,500
Bermuda Dunes	15,800
Palm Springs	18,000
Thornton	4,200
Banning	8,800
Perris Valley	11,750

Commercial service is available at the Palm Springs Airport, while lease or charter service is available at some of the others. In addition, there are some heliports or helipads within 10 miles of the proposed route. West of

Cleveland National Forest, in California, the proposed route passes near the U.S. Marine Corps practice takeoff and landing heliport, occasionally used for Forest Service fire suppression activities.

In summary, the California route (Mohave-Serrano) would cross the following transportation facilities:

12 highways

6 railroad tracks

28 telephone lines

7 aqueducts

13 electric transmission lines

18 oil and natural gas pipelines

4 water pipelines

Numerous documents, including land use plans, management programs and route-feasibility studies, were reviewed in the preparation of this chapter segment. They were predominantly not site specific and, consequently, not referenced in the body of the text. Titles do, however, appear in the bibliography.

Limestone quarry impact area

Livestock grazing

This area is normally grazed on a rest-rotation system, two years out of three. The 160 acres necessary for the proposed quarry, shop and office, magazines and stockpile would otherwise provide for about 64 AUMs or about 64 cows per month. Approximately 650 cattle graze the national forest land in this area, on two allotments, from June 1 to September 30. Approximately 300 of these cattle graze adjacent state lands from September 15 through December 1.

Livestock use live water at Tom Best and Prospect springs. Rain water and snow melt collected in ponds is available intermittently.

Mineral development

There is no significant mineral development near the proposed quarry. Oil and gas leases cover much of the national forest and state lands, but no drilling has taken place. There are several sand and gravel pits in Johns Valley and along State Highway 12 to the south, primarily for local road surfacing and maintenance. There is sufficient material in these pits to supply aggregate for construction and road building at the proposed quarry site.

Wood products

There are approximately 50,000 board feet of commercial ponderosa pine. There has been no harvesting of this timber. The ridges are covered with pinyon pine which local people use for firewood.

Agriculture

There is no agriculture in the immediate area. The nearest agricultural use is near Widtsoe Junction in Johns Valley, where several hundred acres of alfalfa and grain are grown. The fields are irrigated by water diverted from Tom Best Springs, south of the proposed quarry site.

Transportation facilities

Transportation facilities between the proposed quarry site and the Fourmile Bench site include about 62 miles of road and an FAA landing field (see Illustration II-56).

The roads include approximately 15 miles of paved highway (State Highway 12 from the "Y" junction to Cannonville and 3 miles of paved county road from Cannonville to the Garfield-Kane County line), 12 miles of graded, gravelled road (Widtsoe Junction road along Johns Valley) and 35 miles of graded, unimproved road, from the quarry site to Widtsoe Junction road and from the Kane-Garfield County line to the Fourmile Bench site.

Land use planning

Kaiparowits Plateau impact area

Three major land use plans have been or are being prepared for the Kaiparowits plateau impact area. These are the Kane County Master Plan, the Bureau of Land Management (BLM) Management Framework Plan (MFP) for the Paria Planning Unit, and the master plan for the Glen Canyon National Recreation Area.

The Kane County Master Plan of 1970 is "general and long range in nature," in that "the plans suggest policies and proposals, and do not indicate specific locations or detailed regulations." (Kane County Master Plan, 1970) (Figure II-57). The plan considered residential, commercial, recreational, and agricultural land use, public facilities, new town site proposals, and community master plans. The proposed East Clark Bench townsite was one of two alternates considered in the master plan for a new community. No site was selected; however, the plan identified a need for intensive studies and site investigations to determine site suitability.

Present Kane County zoning at the proposed townsite includes forest recreation (FR) and single family residence (R-1) zoning. Most of the site is zoned FR-20 as described in Figure II-57. Remaining portion of the site is zoned R-1-10.

The BLM MFP for the Paria Planning Unit, which includes the Kaiparowits area, was prepared in 1971-72. This plan is part of the BLM land use planning system, and establishes a framework for management of a specific planning unit. The land use activities included in the MFP are lands, minerals, range management, forest products, watershed protection, recreation and wildlife.

The MFP did not treat the proposed Kaiparowits project in detail; however, the proposed power-transmission corridors and new townsite were considered.

FIGURE II-57

Kane County Zoning on the Proposed Town Site

Chapter 13. R-1 SINGLE FAMILY RESIDENCE ZONE

13.1. Purpose

To provide appropriate locations where low density residential neighborhoods may be established, maintained and protected. The regulations also permit the establishment of, with proper controls, the public and semi-public uses such as churches, schools, libraries, parks and playground, which serve the requirements of families. The regulations are intended to prohibit those uses that would be harmful to a single-family neighborhood.

13-2. Permitted Uses

1. Agriculture, as defined herein
2. Single-family dwellings
3. Household pets; home occupations
4. Accessory uses and buildings

13-3. Conditional Uses

1. Art museum, public
2. Church
3. Library, public
4. Mobile Home Park
5. Parking lot for permitted use
6. Public building
7. Park or playground, public
8. Public utility
9. Public school

13-4. Height Regulations

No main building shall be erected to a height greater than 35 feet or two and one-half stories, whichever is greater, and no accessory building shall be erected to a height greater than one story or 15 feet.

13-5. Area, Width and Yard Regulations

District	Area in Square Feet	Lot Width in Feet	Yards in Feet Front	Side	Rear
R-1-10	10,000	80	30	10 & 14	30
R-1-12	12,000	95	30	10 & 15	30

13-6. Modifying Regulations

Side yards-main buildings other than dwellings shall have a minimum side yard of 20 feet and the total of the two side yards shall be 40 feet. Private garages and other accessory buildings located at least 10 feet behind the main building may have a side yard of one foot, except that the street side yard of a corner lot shall be a minimum of 20 feet for main and accessory buildings.

Rear yards-private garages and accessory buildings located at least 10 feet behind the main building may have a rear yard of one foot provided that on corner lots rearing on the side yard of another lot, the minimum rear yard for all buildings shall be 10 feet.

Chapter 19. FR FOREST RECREATION ZONE

19-1. Purpose

To permit the necessary exploitation of the mountainous areas for grazing, forestry, mining, recreation and other activities to the extent compatible with the protection of the natural and scenic resources of the areas for the benefit of present and future generations.

19-2. Permitted Uses

1. Agriculture, as defined herein
2. Cabins for seasonal occupancy but not for year round use
3. Forest industries
4. Livestock grazing
5. Logging and lumber harvesting
6. Mines, quarries, and gravel pits
7. Public recreation grounds and facilities
8. Accessory buildings and uses

19-3. Conditional Uses

1. Reservoirs and hydroelectric facilities
2. Public utilities
3. Recreation camps
4. Lodges and dude ranches
5. Public buildings

19-4. Height Regulations

No building shall be erected to a height greater than two and one-half stories or thirty-five feet.

19-5. Area, Width, and Yard Regulations

District	Area	Width	Yards in Feet Front	Side	Rear
FR.05	1/2 acre	100'	50	20 & 20	30
FR.1	1 acre	150'	30	10 & 10	30
FR.5	5 acres	400'	30	10 & 10	30
FR.10	10 acres	600'	30	10 & 10	30
FR.20	20 acres	600'	30	10 & 10	30
FR.40	40 acres	600'	30	10 & 10	30

19-6. Modifying Regulations

Side yards-main buildings other than dwellings shall have a minimum side yard of 20 feet and the total of the two side yards shall be 40 feet. Private garages and other accessory buildings located at least 10 feet behind the main building may have a side yard of 1 foot, except that the street side yard of a corner lot shall be a minimum of 20 feet for main and accessory buildings.

Rear yards-private garages and accessory buildings located at least 10 feet behind the main building may have a rear yard of 1 foot provided that on corner lots rearing on the side yard of another lot, the minimum rear yard for all buildings shall be 10 feet.

From Kane County, Utah - Zoning and Subdivision Ordinance; October 12, 1970

The proposed East Clark Bench townsite is identified as the primary site for community development.

The Glen Canyon National Recreation Area Master Plan is being developed by the National Park Service. Hearings were held on the preliminary plan in the summer of 1975. The plan identifies objectives for maintaining natural processes and facilities and for protecting recreational and other values unique to the Glen Canyon National Recreation Area.

Transmission system impact area

Introduction

The proposed transmission system would cross the following western states and their respective counties:

State	County
Utah	Kane
Utah	Washington
Nevada	Lincoln
Nevada	Clark
Arizona	Coconino
Arizona	Yavapai
Arizona	Maricopa
Arizona	Mohave
California	San Bernardino
California	Riverside
California	Orange

Utah

State and local planning

All lands subject to planning in Kane and Washington counties are rural and sparsely populated; planning is quite generalized. The plans, therefore, do not

specifically consider tracts to be crossed by the proposed transmission lines.

Present zoning also reflects the rural nature of lands which would be affected by the proposed transmission lines. Almost all such lands are zoned for rural-type land uses, which provide for open land and low density, extensive uses such as livestock grazing and recreation. Conditional-use permits are the means for allowing other uses of rural lands.

Federal agency planning

The BLM administers most of the land along the proposed routes, and has completed initial resource planning for land which would be crossed. The names of the geographical planning units are Paria, Vermillion Cliffs, and Beaver Dam.

Most of the proposed Utah routes are in corridors identified in the BLM resource plans, except where the proposed routes would cross the Beaver Dam Mountains in Washington County. The BLM planned corridor routing is north of the Beaver Dam Mountains, in lieu of proposed routes crossing these mountains.

Nevada

State and local planning

The proposed routes through Nevada are mostly through rural, sparsely-populated areas in Lincoln and Clark counties. The exception is the heavily populated Las Vegas Valley in Clark County. Local and state planning is general in nature. Such planning does not specifically consider tracts in the path of the proposed transmission lines.

Present zoning also reflects the rural nature of the land. All such land is classified for "open use" in these two Nevada counties, allowing most land uses. Zoning along the eastern edge of the Las Vegas Valley allows for transmission lines, but requires a special-use permit.

Federal agency planning

The BLM administers most of the land along the proposed routes. It has completed initial resource planning for national resource land proposed to be crossed.

Virgin Valley and Stateline are BLM names for these planning units. The proposed routes are compatible with general corridors identified in the planning. Other federal agency planning is not specific concerning transmission line corridors.

Arizona

State and local planning

The State of Arizona has no single agency directly responsible for land use planning. All four Arizona counties concerned (Coconino, Yavapai, Maricopa and Mohave) have planning commissions, but only Maricopa County is actively engaged in land use planning. This county has made basic studies of population, economics and land use. From these, land use and transportation plans have been developed and implemented. Transmission corridors, however, were not identified in these plans.

Mohave County has a "blanket zoning" policy that covers all rural areas. Land in the proposed route in Mohave County is zoned A-R (agricultural-residential) and R-E (residential-recreation). A-R permits single family dwellings and agricultural uses. R-E permits single family dwelling, recreation areas, public buildings and commercial activities.

Mohave County has obtained from BLM a long term lease under the Recreation and Public Purposes (R&PP) Act for an entire section south of Bullhead City and east of Highway 95. The purpose of the lease is a county park, but no development has taken place. The proposed line would cross the parcel. The county has 5 years to develop the site under terms of the R&PP Act.

Coconino and Yavapai counties have no land planning or zoning completed for areas the proposed route would cross.

Federal agency planning

In northern Arizona BLM has completed the initial phase of resource planning for three areas which would be crossed by the proposed routes. The planning units are Coconino, Antelope and Grand Wash Cliffs. A transmission corridor identified in these plans would accommodate the Kaiparowits to Eldorado route and the Northern Kaiparowits to Mohave preferred alternate. The Arizona Strip preferred alternate route is not an identified corridor. A BLM study, The Impact of Power Transmission Lines and Their Effect on the Southwest Environment was published in late 1970. It was made in response to a request by the Los Angeles Department of Water and Power (LADWP) to locate the Navajo to McCullough 500 kV transmission line on approximately the same route as the participants' proposed "preferred Arizona Strip Alternative," discussed in Chapter I of this report. The proposed Arizona Strip route was analyzed by a multi-disciplined team and public hearings were held to obtain public reaction. There was strong public opposition to permitting the proposed route to cross the Arizona Strip. The study suggested that less environmentally sensitive alternative routes be used. As a consequence, the present LADWP Navajo to McCullough route was chosen.

In the central-west portion of Arizona (Moenkopi to Mohave), BLM resource plans are complete for lands which would be crossed by the western half of the route (35 miles). This area has been labeled the Cerbat Mountain Planning Unit. A utility corridor was established south of the proposed route, through the Cottonwood Cliffs along an existing 230 kV Bureau of Reclamation transmission line. The proposed route would enter this corridor west of the Cottonwood Cliffs.

The southern Arizona route (southern part of the Kaiparowits to Phoenix segment) would cross the BLM designated Black Canyon Planning Unit. Initial BLM

planning is complete for this unit. Two 500 kV Arizona Public Service transmission lines cross this unit on the east side of Highway I-17. The route is identified in the BLM plan as a utility corridor, but no provision is made for a 2,000-foot separation between lines, for 36 miles east of the Rock Springs and Black Canyon City areas. Between Highway I-17 and the two Arizona Public Service transmission lines, BLM plans call for undisturbed, open space, scenic recreation uses.

This proposed route would also pass through Kaibab, Coconino and Prescott National Forests. A Forest Management Plan has been initiated for Kaibab but is not yet complete. Plans are complete for Coconino and Prescott National Forests, and utility corridors are provided along the proposed route. However, no provision has been made for a 2,000-foot separation of transmission lines.

California

State and local planning

State, county and local land use planning recommendations for the impact area are general in nature. Specific utility corridors have not been identified. San Bernardino County plans identify resource reserves and preservation of natural resources, and zoning in open land.

Riverside County plans, from the boundry with San Bernardino County to Devers substation, call for preservation of "open space." Zoning is mostly "open space," with some residential development. The San Gorgonio Pass General Plan recommends "open space" with some residential zoning along the south edge of Cabazon. The rest of Riverside County is planned for a combination of open land, residential, industrial, and agricultural uses.

The Orange County portion of the route has an open land designation and range land zoning. Serrano substation within the Orange city limits is on land zoned for industrial use.

Federal agency planning

Federal agency planning for areas crossed by the proposed transmission lines is general in nature. No transmission corridors have been identified in southern California.

Indian reservations

Resource planning is not complete for Indian reservations along the proposed routes. The reservations that could be affected are the Navajo, Haulapai, Kaibab, Aqua Caliente, and Morongo.

Impacts on current land use planning is discussed under Land Uses in Chapter III.

Numerous land use plans, programs, and studies were reviewed in the preparation of this chapter. Because of their general approach to the proposed routes they are not referenced in the text, but are listed in the Chapter II bibliography.

Limestone quarry impact area

The U.S. Forest Service has prepared a multiple-use management plan that includes national forest land which would be used by the proposed quarry. The last revision of the plan was 1965. This plan was comprehensive, but passage of the National Environmental Policy Act of 1969 has necessitated revision. A revised plan will be completed in 1975.

Socioeconomic factors

Kaiparowits Plateau impact area

Southern Utah

Fourmile Bench is in Kane County 15 miles south of the Garfield County line. Escalante, population 638, is the largest community in that part of Garfield County which would be most affected. Other towns in the area include Boulder, population 93; Henrieville, 145; Cannonville, 113; and Tropic 329 (see Illustration II-59). These populations total 1,318, almost equal to Kanab 1,381. Census figures (1970) for the county subdivisions which include these towns are as follows:

	Population
Garfield County	
Escalante Division	789
Tropic Division	819
Kane County	
Kanab Division	1,621

These divisions represent about half the population of the two counties. Following are statistics on population for both Garfield and Kane counties, showing growth and decline:

	1930	1940	1950	1960	1970	Est. 1973
Garfield	4,642	5,253	4,151	3,577	3,157	3,100
Kane	2,235	2,561	2,299	2,667	2,421	2,700

Source: U. S. Census

Since 1940 the Escalante area has consistently lost population. Outmigration has been greater than natural increase. State road 12 from Highway 89

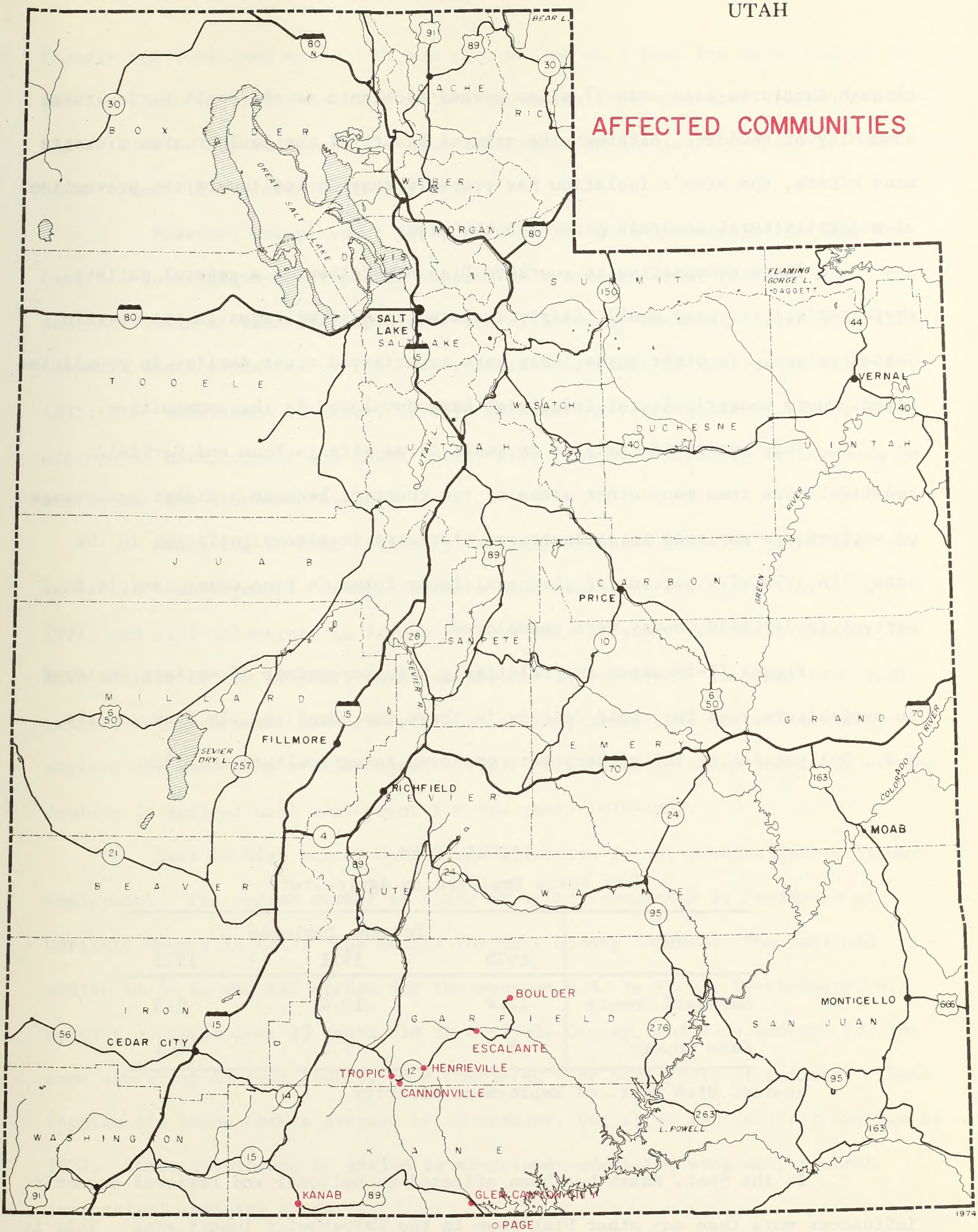


ILLUSTRATION II-59

Affected Communities

through Escalante dead ends 27 miles beyond Escalante at the small agricultural community of Boulder. Although the natural beauty of the Boulder area attracts many hikers, the area's isolation has probably contributed toward the prevention of nonagricultural economic growth in the area.

These communities in southern Utah are following a general pattern characteristic of many small, fairly isolated farming villages in the western United States. In other words, they have experienced a net decline in population except where nonagricultural industries have developed in the communities.

This nationwide decline in small farms affects Kane and Garfield counties, more than many other areas of the country, because a higher percentage of workers are employed in agriculture. Forestry is also significant in the area. In 1973, 7.3 percent of the total labor force in Kane County and 14.6 percent in Garfield County were unemployed.

Figure II-58 shows the relatively high percentage of workers employed in agriculture, and the rapid decline in these two counties. In Utah and the U.S., 3.1 percent of the workers were employed in agriculture in 1970.

FIGURE II-58
Work Force Employed in Agriculture

County	Percent Employed		
	1970	1971	1972
Garfield County	11.4	10.4	8.8
Kane County	8.7	7.1	6.1

Source: Utah Dept. of Employment Security

In the past, Kanab has been affected by national and regional economic influences more than any other Utah town in the Kaiparowits impact area. This is because Kanab is located on Highway 89 and is visited by travelers between the

Phoenix and Salt Lake areas. It has also served as a base for movie makers who use the picturesque Utah scenery as background in their pictures. Kanab's strategic location has made possible some employment in the tourist industry, but unemployment in the area is fairly high.

However, unemployment patterns such as those encountered in Kane and Garfield counties may be expected because of numerous social factors, viz., the dominant forms of recorded employment are affected by seasonal variations; socio-economic characteristics of the county (Utah Department of Employment Security, 1975; U.S. Department of Labor, 1975); characteristics of the work force; definitions of unemployment and labor force; etc. The major factors influencing unemployment are discussed below.

Among the 29 Utah counties, Garfield and Kane counties rank first and second in unemployment. Unemployment is also seasonal, as figures for 1970, 1971, and 1972 illustrate in Figure II-59. This seasonal factor is present in most sectors of the economy, but fluctuations in employment in other than agriculture and government have the greatest effect, since this "other" sector employs the most people (see Figure II-60). Figure II-60 also shows the steady decline in agricultural employment for the years 1970-1972.

Lack of high school or college education is not a major factor in unemployment. The median number of years of school completed by residents of Garfield County is 12.2. The median for Kane County is 12.5. The national median is 12.1, and the median for the western U.S. is 12.4. Furthermore, 8.7 percent of those over 25 years old in Garfield County, and 13.4 percent for the same age group in Kane County, have completed 4 or more years of college. These figures are below Utah's average of 14 percent, but above the national average of 10.7. State government is active in vocational-education programs, to meet industries' changing needs.

FIGURE II-59

Historical Seasonal Unemployment

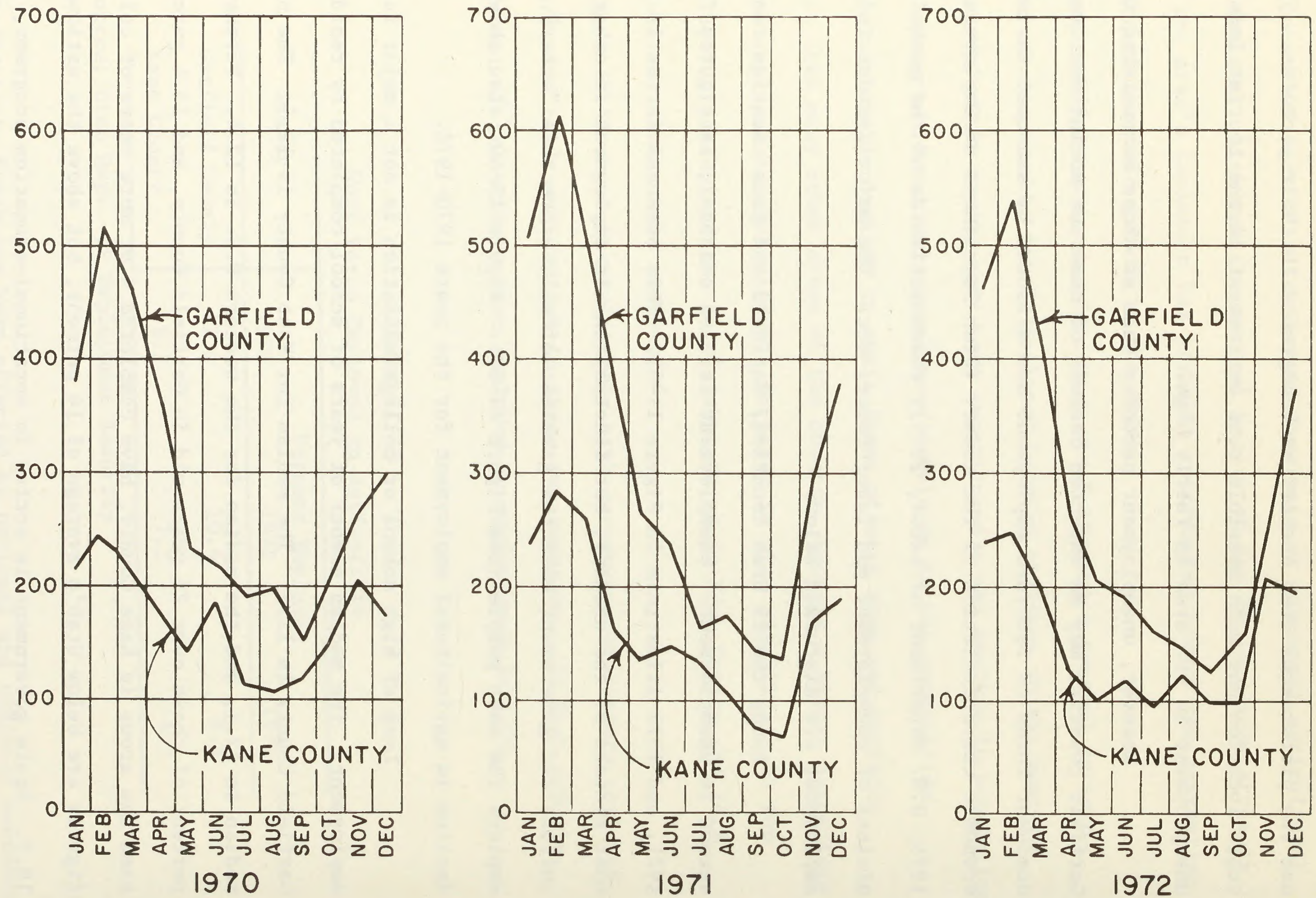
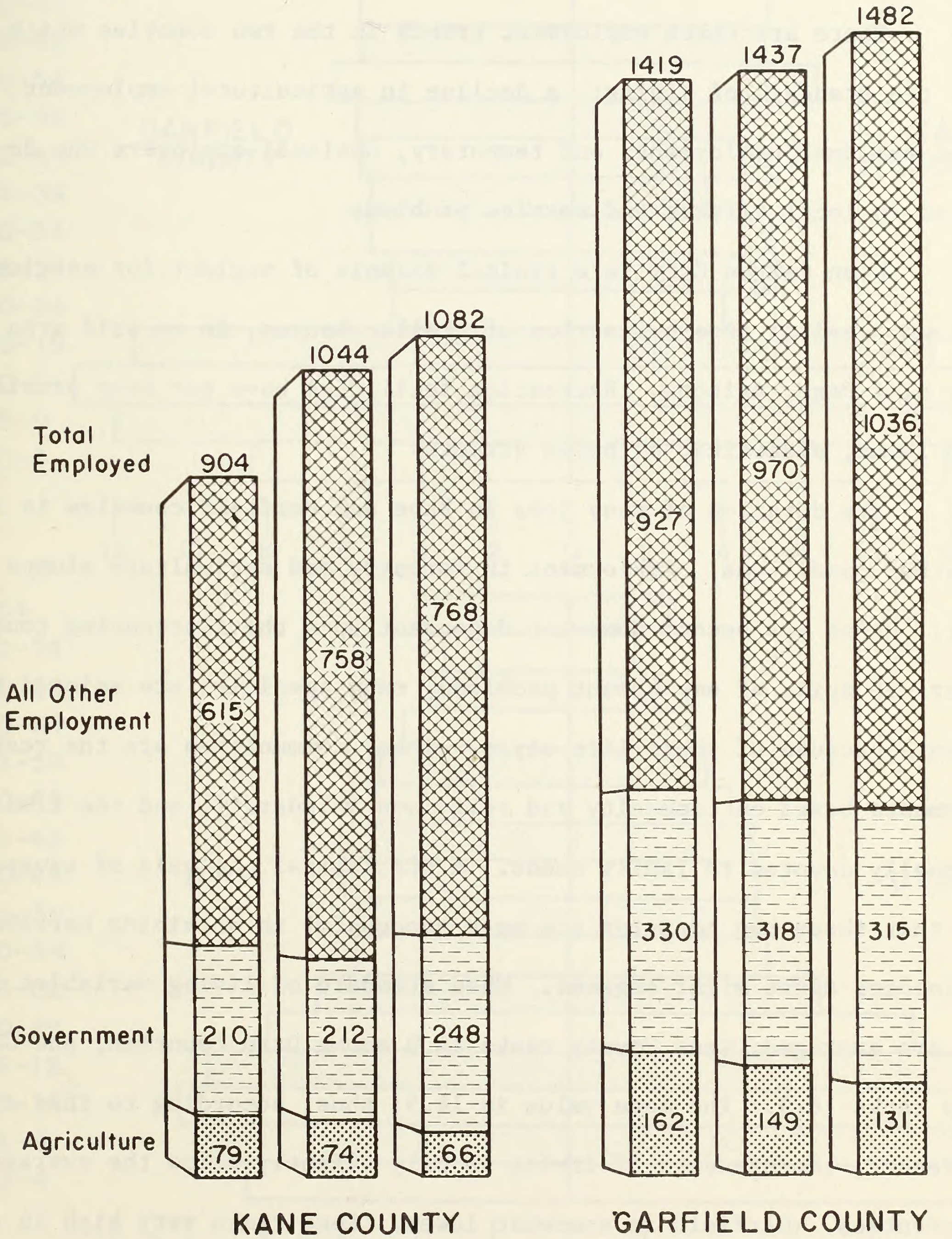


FIGURE II-60

Employment for Kane and Garfield Counties
(1970-1972)



The attrition rate of people in the 20-to-30 age bracket is particularly high (see Figure II-61). As shown in the figure, only 4 to 5 percent of the population in these two counties is in the 20-to-30 age grouping. The average for Utah ranges from 7 to 9 percent. The U.S. profile shows that 8 percent of the population falls between 20 and 25, and 6.5 percent between ages 25 and 29.

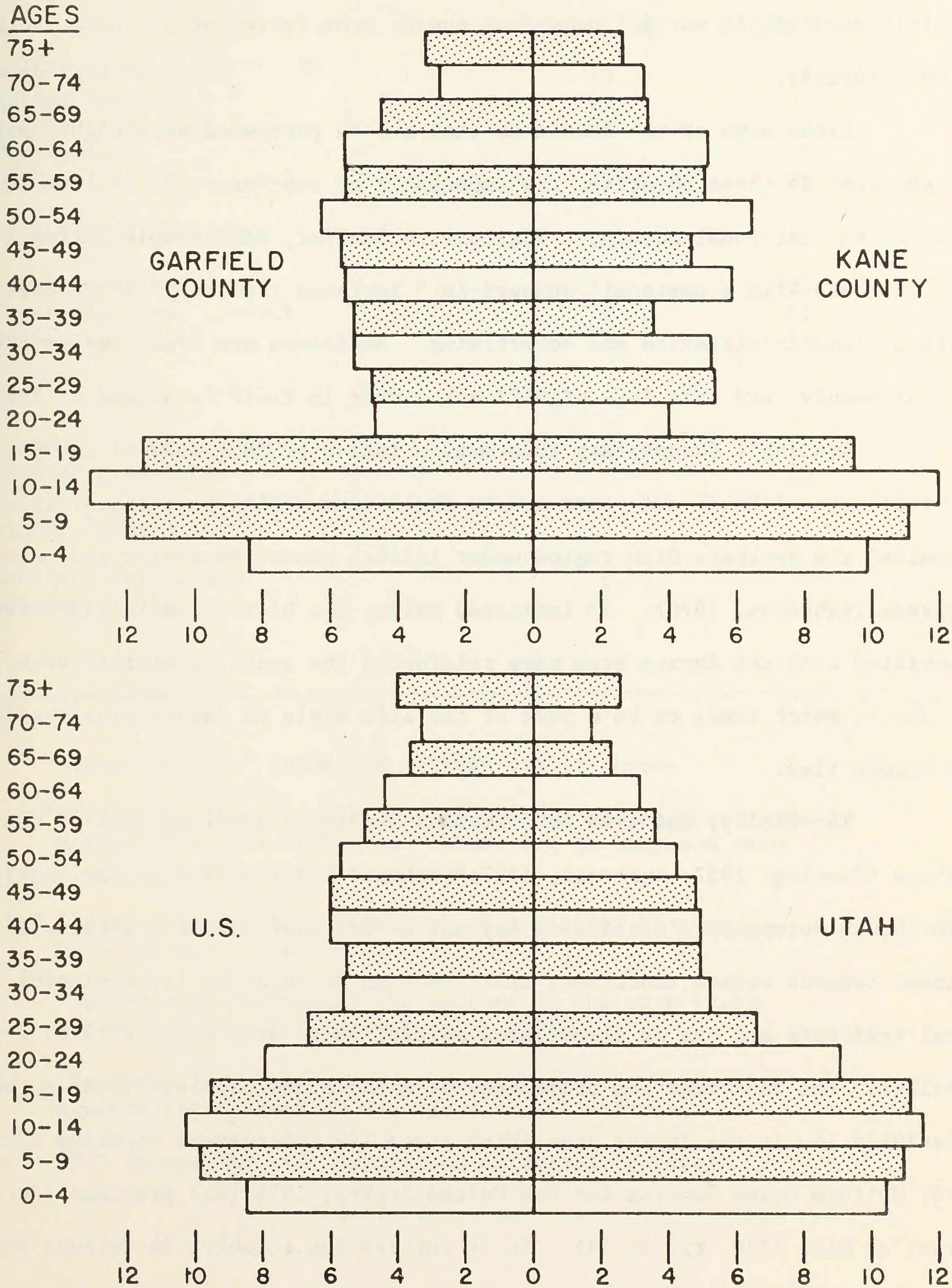
There are three employment trends in the two counties which greatly affect the standard of living: a decline in agricultural employment, a great deal of seasonal employment, and temporary, nonlocal employers who do not become involved in local affairs and service problems.

Glen Canyon City is a typical example of neglect for service needs. This town consists of a collection of trailer houses, in an arid area of Kane County near Page, Arizona. Recreation facilities have not been provided. There are no lawns, sidewalks, or paved streets.

The duration of many jobs in Kane and Garfield counties is influenced by weather conditions. Employment in forestry and agriculture slumps during the winter. Kanab has become somewhat dependent upon the fluctuating tourist trade. However, in spite of employment problems, many amenities are enjoyed by the residents because of their life style. These communities are the result of early settlements based on community and religious solidarity, and the limited incomes are usually devoted to family needs. A statistical analysis of several factors shows that these two counties are more successful in obtaining certain amenities than incomes alone might suggest. When standard of living variables in Figure II-62 are averaged, Kane County ranks 14.9 among Utah counties, and Garfield County ranks 16.9. The mean value is 14.5; thus, according to this system of measurement, the standard of living is only slightly below the average of all Utah counties. Garfield is somewhat lower. Kane ranks very high in education

FIGURE II-61

Age Distribution (Percentage)



and Garfield better than average. Per capita income and dentists per capita are better than average in both counties. Auto ownership is high for Garfield but very low in Kane. Figure II-62 reveals that the standard of living in Kane and Garfield counties is not as low as may appear from review of a single factor such as unemployment.

Since some of the amenities that can be purchased with higher wages are not abundant in these counties, the importance of aesthetics in the communities takes on an additional meaning. Visitors to Boulder, for example, often comment that it looks like a pastoral "Shangri-la," isolated from many of the visible marks of industrialization and advertising. Residents are conscious of the natural beauty, and this is a significant factor in their "standard of living."

Available documentary information indicates that many of the present day residents of Kanab and other nearby small communities have ancestors who colonized the southern Utah region under initial Mormon expansion and colonization programs (Robinson, 1970). As indicated below, the history and social circumstances associated with the impact area have reinforced the sense of social-psychological solidarity which tends to be a part of the life style of impact area residents and communities.

The family, and even the extended family is a valued part of the local culture (Canning, 1957; Anderson, 1937; Kephart, 1961; Life Magazine, 1947). Even though documentary statistics may not be the most adequate measure of commitment towards formal education, still such an orientation is meaningful to the local residents and can be illustrated several ways (U.S. Census, 1970, P-224). Similarly, the incidence and prevalence of major crime problems tends to be relatively low in the impact area (Utah State Law Enforcement Planning Agency, 1974; Uniform Crime Reports for the United States, 1974 (and previous years); Davis, et al., 1974, pp. 32-34). It is interesting to note, in various publications, that the impact area residents emphasize respectful relationships to

FIGURE II-62

Kane and Garfield Counties' Ranking Among Utah's 29 Counties for Selected Standard of Living Variables (1970)

	Kane County	Garfield County
Income		
Mean-families	15	14
Median-families	16	23
Middle class size	21	28
Per capita	13	12
Employed	29	28
Housing and Auto Ownership		
Owner-occupied: value	15	21
Owner-occupied: number	10	15
Registered autos	29	12
Education		
Expenditure per student	4	8
Teacher class load	6	16
Medical and Dental		
Dentists per capita	9	5
MDs per capita	24	18

Notes: "Mean-families" means the average family income

"Median-families" means the wage earned by the one in the middle of the distribution - there are as many who earn more as there are who earn less.

"Middle class size" means lack of variation between mean and median incomes.

"Number employed" means the percent in the work force who are not on state unemployment rolls.

"Teacher class load" means the smallness of the teacher-student ratio based on average daily attendance.

Source: 1970 Census and Utah Department of Social Services

political and religious officials. Undoubtedly, as many writers infer, this is traceable to the residents' religious orientation (Linford, N.D.; Benson, 1974; Caldwell, 1952).

Numerous writings attest to the religious underpinning of Utah residents, particularly residents of southern Utah. The valuative emphasis on work, being employed, being physically active, maintaining community as well as family solidarity, the development of musical, literature and aesthetic appreciation can be found integrally a part of the culture (Arrington, 1970 and 1973; Stegner, 1942; O'Dea, December 1953, 1964, 1972).

There is also at least a historical, if not a present ecological sensitivity reflected in land use planning, patterns, and particularly, communal patterns (Nelson, 1958, 1954; Campbell, 1974; Meinig, 1965; Fox, 1932). It may be, however, that this earlier commitment is changing (Public Hearings on the Kaiparowits EIS, 1975, pages 14-156).

Sociologists have tended to refer to or theorize about communities with such characteristics as "holistic," "community as society," and "personal communities" (Effrat, 1973). Based on the study of change, social problems, and disorganization, some sociologists have indicated how communities such as those in the impact area have a vulnerability to disorganization when major social and economic conditions come about which alter the status quo (Merton, 1957, 1961; DeGrazia, 1963; Smith, 1971).

Communities in Kane and Garfield counties are able to supply services only with considerable difficulty. Water is not readily available and sewers are adequate only for present populations. Schools are somewhat better. All public schools in three towns within 60 miles of Fourmile Bench are underenrolled. The combined enrollment in Escalante, Tropic, and Panguitch is about 800. This represents about two-thirds of the peak enrollment in previous years. Facilities are adequate for 300 additional students.

Several sites near Fourmile Bench may be suitable for development of new towns, from a physical standpoint, but there are few established communities to serve as bases for expansion. The largest community near Fourmile Bench is Page, Arizona, 69 miles from the proposed site on dirt and paved roads. If the new highway is built as proposed, the distance between Fourmile Bench and Page would be about 49 miles. Kanab is 109 miles from Fourmile Bench, Escalante 30, Panguitch 60, Cannonville and Henrieville 35 and 39 miles, respectively. In some cases, lack of paved roads limits travel between these communities.

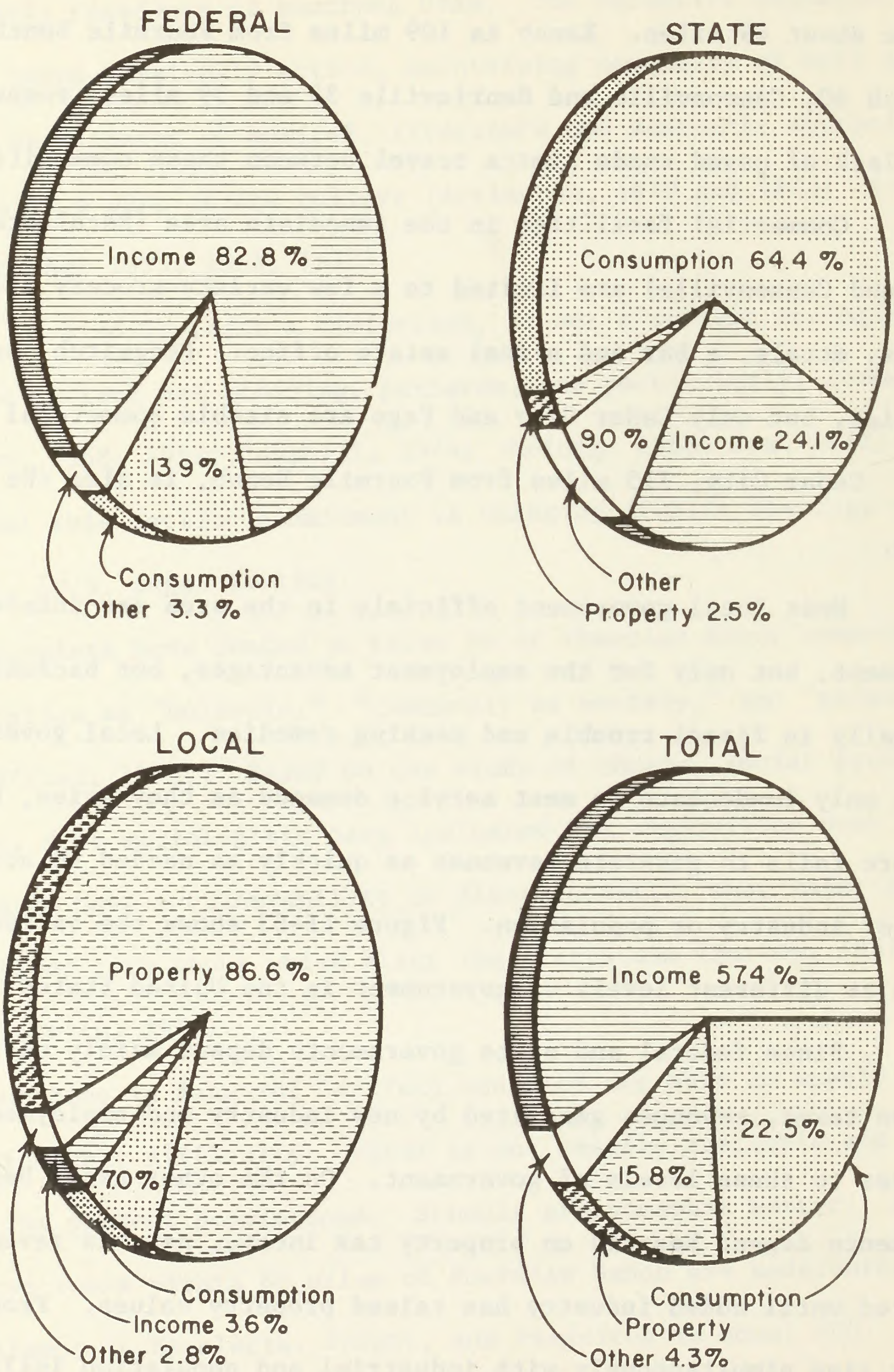
Commercial facilities in the immediate area (Escalante, Tropic, Henrieville, and Cannonville) are limited to a few variety-grocery stores, service stations, motels, a bar and a real estate office. Panguitch has a few more facilities, but only Cedar City and Page are sizable commercial centers for the region. Cedar City, 115 miles from Fourmile Bench, is also the location of a 4-year college.

Most local government officials in the area are interested in economic development, not only for the employment advantages, but because the communities are usually in fiscal trouble and seeking remedies. Local government revenues are not only inadequate to meet service demands as they arise, but the taxing structure fails to generate revenues as quickly as needed to accommodate an influx of industry or population. Figure II-63 shows the various sources of revenue at different levels of government in the United States.

Since federal and state governments depend mainly on income and consumption taxes, revenues generated by new industry and employment give timely increases to these levels of government. On the other hand, because local governments depend heavily on property tax income, new tax revenues are not generated until added industry has raised property values. Property values usually rise simultaneously with industrial and population influx, but not as

FIGURE II-63

Federal, State and Local Tax Revenues (1968)
Distributed Among Broad Tax Categories



fast as the demand for services increases. Such taxes also constitute a smaller percent of revenues generated than do consumption and income tax revenues.

Kane and Garfield counties have received some state and federal assistance through the Five County Association of Governments, and from the Four Corners Regional Commission. See Illustrations II-60 and II-61.

The Five County Association includes Kane, Garfield, Washington, Iron, and Beaver counties. It is one of seven such associations in Utah established to deal with regional programs. The Four Corners Regional Commission includes governors of the four states (Arizona, Colorado, New Mexico and Utah) or their alternates, and a federal appointee. The Commission's role is to develop and sponsor regional economic programs.

The importance of regional associations in planning energy-related programs has already been demonstrated. The Four Corners Regional Commission has made grants for new town studies, coal technology education, and land development programs. Needed programs and funding cannot be generated solely by the local economies because of the tax structure and the suddenness of demands made on local governments. Regional associations can help with a few selected projects, but do not have the authority or funding to deal with most of the service needs of growing communities.

Page, Arizona

Page is 19 miles from Glen Canyon City, and 49 miles from Fourmile Bench over the proposed highway. See Illustration II-59 for the location. Page was settled in 1957 by employees working on Glen Canyon Dam, and for the past 4 years has benefitted economically from construction at the Navajo generating plant. Beginning in 1975 there has been a decline in both population and the economy. A still lower level of population and employment will be reached in 1976, when the third and final unit of the Navajo plant is completed. If other

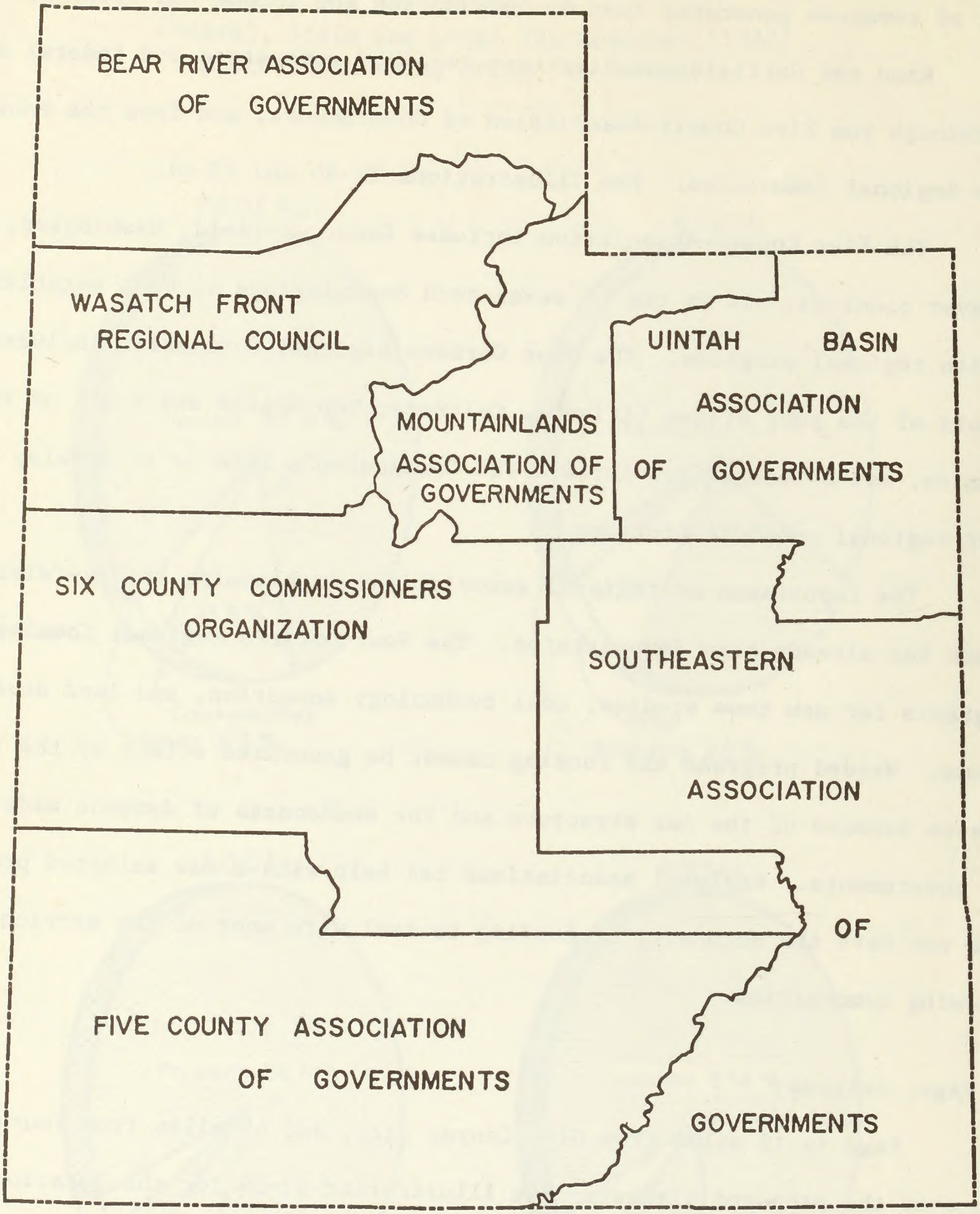


ILLUSTRATION II-60

Multicounty Associations of Government

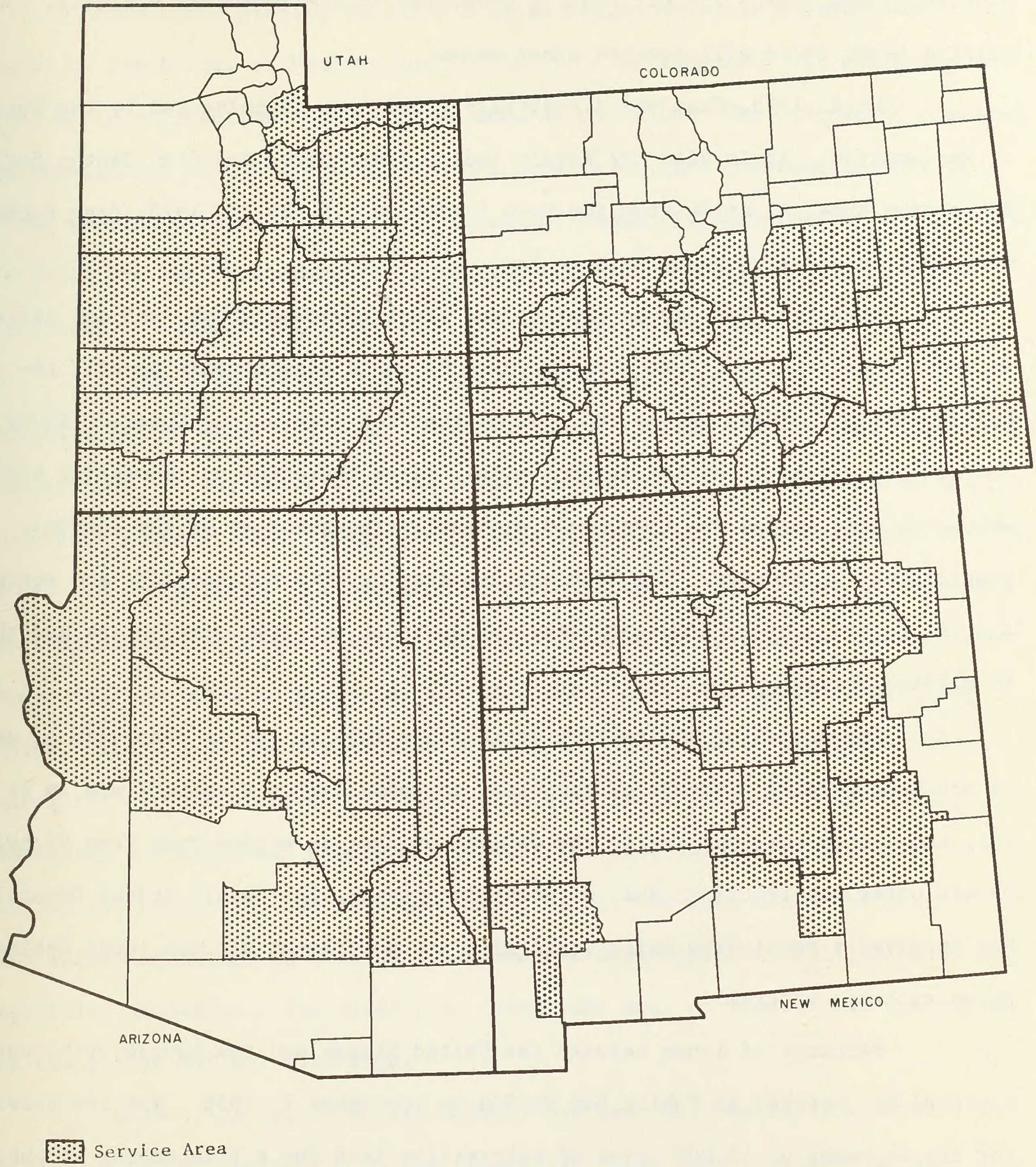


ILLUSTRATION II-61

Four Corners Regional Commission Service Area

sources of employment are not rapidly developed in the immediate vicinity, the skilled labor force will move to other areas.

Until 1975, Page was a federally-owned town administered by the Bureau of Reclamation. It is near the Navajo Indian Reservation and Glen Canyon National Recreation Area, 11 miles from the Utah Border on U.S. 89. In 1975, Page became a municipal corporation under Arizona law.

When the Glen Canyon project was first proposed, both Utah and Arizona wanted the construction town located where it would economically benefit respective states. Utah wanted the town on the Utah side of the Colorado River, and Arizona wanted it on the Arizona side. Since there was no connecting bridge, whichever side gained the town would eventually receive most of the economic benefits of the project. The town was the staging area for supplies and equipment, and the location of housing necessary to construct the $421 million dam and the $4 million bridge.

The Bureau of Reclamation established Page on the Arizona side of what is now Lake Powell. The choice was based on these facts: Flagstaff was to be the railroad center for supplies to the dam and bridge; an access road from Highway 89 was under construction; and, of great importance, the Navajo Tribal Council had approved a resolution which would give the government all the lands desired in an exchange program.

Exchange of lands between the United States and the Navajo Tribe was approved by Congress in Public Law 85-868 on September 2, 1958. The law provided for the exchange of 53,000 acres of reservation land for a like amount of public land in the McCracken Mesa area in Utah. The Navajo Tribal Council had also wanted to exchange mineral rights; but since it was known that the McCracken Mesa area had oil deposits, only surface rights were exchanged. By excluding mineral rights from the exchange, the Interior Department said, difficult legal questions of "equivalent value" were avoided.

From the beginning in 1957, a large degree of local autonomy was granted by the Bureau of Reclamation for the town development. It was expected to become an incorporated community as soon as possible. The contractor provided some housing for his work forces, and the government also constructed housing. But the government did not erect buildings for commercial enterprise. Areas were made available for development of a business district by private firms and individuals. Leaseholders later got first chance to buy this land.

As the Glen Canyon project got underway and Page began to boom, a 5-year sociological study was made, entitled "Page, Arizona - A Rootless Community?" In this study, it was found that the people tended to group themselves along occupational hierarchies. These groups were "government," the "prime contractor and his subcontractors," and "commercial-professional." Leadership in community organizations and programs (Lions, Chamber of Commerce, Boy Scouts, recreational association) was made up predominantly of those high in the occupational hierarchies. There was also competition between the "government" group and the "contractor" group relative to the importance of their jobs on the project. "Commercial-professional" group members were the ones primarily interested in building the community, and they came under attack for what others believed to be their unfair advantage in pricing goods and services beyond normal limits in a competitive situation. The study also found that most of the workers identified with their jobs and not with Page.

In 1964 the Page Advisory Council was set up to assist the Bureau of Reclamation in administration of the community. This body consisted of six elected representatives, with one Bureau employee appointed to represent the government. In the 1974 Advisory Council election three council seats were filled with 4-year terms. Only 518 people voted, of an estimated population of over 9,000. This small turnout could mean that residents are not interested in self-government or, as found by the earlier sociological study, few resident

workers and their families identify with the community. Or it may mean that lack of local control discourages citizen participation, since council decisions could be overruled by the Bureau of Reclamation.

Because of the close association of Page with the dam project, the construction company and the Bureau of Reclamation participated in solving some service problems which arose when Page was established. Many such problems, therefore, were solved more quickly than in most boom towns.

At first there were no shops; all food, water, and supplies had to be brought in. There were no paved roads and the only way out was by way of Coppermine Road, 50 miles long. Electricity was supplied by generators, and breakdowns were common. In the first year, children attended classes through correspondence courses. Two of the greatest problems for early residents were wind and sand.

By the second year, improvement had begun. The new route to Highway 89 was completed. A grocery store and post office were opened, and three government quonset huts were set up to serve as classrooms. During the third year (1959), 200 government houses were built, streets were paved, and a business area was laid out. Glen Canyon Bridge, spanning the canyon, was opened for travel in February 1959. A labor strike, beginning July 6, 1959, almost ended Page. For 6 months, the dam site was picketed and the trailer court emptied as workers left in search of new jobs. Many local businesses closed temporarily, some closed permanently. By Christmas a settlement was reached and work resumed.

Since Page was founded as a "company town," its fortunes and population fluctuated as projects at the dam were started and ended. During the peak of construction in 1963, population was near 6,000. Following completion of major construction, the population dropped to 1,348 (See Figure II-64).

Services and facilities provided by the Bureau of Reclamation included an airport, cemetery, fire department, hospital, housing services and maintenance,

FIGURE II-64

Population of Page, Arizona as of January 31, of Each Year

Year	Population
1960	2,634
1961	5,529
1962	5,528
1963	5,920
1964	3,881
1965	1,854
1966	1,714
1967	1,348
1968	1,391
1969	1,750
1970	1,815
1971	3,257
1972	4,610
1973	7,100
1974	9,036
1975	7,259 (April)
1976 (Expected)	5,750*

*Source, city clerk, Page to 1975. The 1976 figure is based on employment decline at Navajo generating plant construction operation.

library, parks and recreation, pest control, police department, refuse collection and disposal, sewage system and maintenance, street and drainage maintenance, water supply, and planning and zoning. Private investment has provided additional services including cable television, a public swimming pool, three grocery stores, eight restaurants, five general merchandise stores, two clothing stores, a drug store, ten service stations, and twelve churches. The town is trying to change from a construction headquarters by placing greater reliance on tourism, recreation, and retirement living.

In addition to the recreation economy supported by Lake Powell facilities, construction of the Navajo power plant has been the most important economic development in the area since the dam construction began. The plant, 3 miles east of Page, is under construction on 1,021 acres of land leased from the Navajo tribe. An additional 765 acres have been leased, 2 miles east of the station for ash disposal. Peabody Coal Company has leased coal under more than 64,000 acres on Black Mesa from the federal government and the Navajo and Hopi tribes. The plant has its own railway, the Black Mesa and Lake Powell Railroad, to haul the coal 78 miles from mine to plant.

In these lease agreements, Indian preference in job hiring was guaranteed, leading to charges by labor unions of discrimination against their workers, and countercharges by Indian groups that not enough Indians were being hired. Local schools, other taxing entities, and the State of Arizona will receive an estimated $7.5 million annually in property taxes, based on expected assessed valuations of the generating station, related transmission lines, coal mine, and railroad.

Residents of Page use local facilities sufficiently to provide private businesses adequate incomes. However, catalog store customers frequently place

large orders for items which are not available locally or priced higher than in the catalogs. A number of residents also visit shopping centers in Flagstaff and Phoenix.

The problem most frequently noted by residents of Page is the lack of attractive private housing. In 1974 there were more than 1,600 mobile homes, housing more than half the population. These mobile homes are in "parks" of widely-varying aesthetic quality. Some provide adequate recreation and are attractive; however, most are in treeless, sunbaked, windswept areas. Services in Page, such as medical facilities and schools, are adequate (Davis, et al., 1973). In the absence of some major new influence on the economy, by 1978 the population of Page may have declined to less than half its 1973 level. It is expected that most of the decline will cause an evacuation of the substandard trailer housing, and most of the more adequate facilities will remain occupied.

By April 1975, the impact of declining employment at the Navajo generating plant was felt. According to statistics collected by the Page City office, the population decreased by 813 in the month of April. The estimated total population on February 28, 1975 was 8,342, the estiamte for March 31, 1975 was 7,529. This decline is expected to continue until something like the Kaiparowits project causes an influx, or until it levels at about 4,000 to 5,000 in 1976. The decline is also revealed in school enrollment figures. Statistics released by the Page public school office reveal that elementary-grade enrollment (kindergarten through eighth grade) reached a peak in 1974 and then began declining rapidly. A similar pattern existed in secondary grades (see Figure II-65).

Since the initial costs of establishing services in Page have been met over the past 20 years by the Bureau of Reclamation and through assessments, physical structures exist to accommodate a population of about 10,000. There are streets, curbs, gutters, schools, sewers, etc. Therefore, taxes can be used to maintain and improve the system, and a population influx would not cause strain

FIGURE II-65

Page Public Schools Student Population

Elementary										
	1970-71		1971-72		1972-73		1973-74		1974-75	
	Semester									
Grade	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st mo.	8th mo.
K	68	75	92	155	112	148	160	203	114	158
1	112	121	147	231	131	189	214	311	214	188
2	112	110	142	214	160	176	182	237	191	179
3	99	96	97	162	126	160	204	243	185	161
4	100	101	137	212	149	197	177	229	192	176
5	99	102	124	201	159	191	214	252	187	179
6	90	90	124	158	155	183	213	261	209	189
7	82	83	108	171	144	180	216	263	211	192
8	98	90	108	175	119	158	205	246	215	195
Totals	860	868	1088	1692	1255	1614	1785	2245	1718	1617
	Sp.	Ed.	9	13		42				
High School										
9	71	73	139	138	163	155	176	165	207	187
10	73	70	98	101	133	133	155	152	165	157
11	59	56	90	85	106	113	135	124	148	130
12	47	49	64	64	87	87	90	92	126	101
Totals	250	258	391	388	489	488	556	533	646	575
Personnel										
Teachers	50		62		91		103		101	
non Teachers	47		57		76		117		139	
Total	97		119		167		220		240	

5. Average size of classes has been 33, excluding special ed classes.

in comparison to that which is felt in a community less prepared to accommodate new residents. Although many of the trailer villages offer only minimal amenities, and Page must cope with the fiscal problems experienced by any town of similar size, the community could readily accommodate a population influx of about 5,000, since an out-migration of approximately this number is expected during 1975 and 1976.

Until Page was incorporated under Arizona law in 1975 the Bureau of Reclamation (BR) contributed capital expenditures and operating and maintenance funds. These amounts are shown in Figures II-66 and II-67. In addition, the "Reclamation Development Act of 1974" provided for additional funds and services to be provided by BR. A copy of this act is located in Appendix III-13. The provision of facilities costing $8,621,960 solved the problem of providing up-front money for Page in the early years of development. Operation and maintenance costs were met by assessing a fee commensurate with the property tax rate being charged at Flagstaff, Arizona. BR funds, taken from the Upper Colorado River Basin Fund, were used to cover operating and maintenance deficits.

After incorporation, BR funds will not be available to Page, except as specified in "The Reclamation Development Act of 1974." However, a comparison of Page to other cities suggests that it would not be necessary to have a budget as large as in the past to provide quality services. See Figures II-68, II-69 and II-70. Since community facilities are established and operating, the shift from federal to community ownership should not place a financial burden on the residents greater than that of most privately-operated communities of similar size. Regardless of the population level, BR has maintained a large staff in Page to provide maintenance and operation of municipal services, whereas a locally-controlled system would be more flexible as population shifts since funding would be more directly related to revenues.

FIGURE II-66

Bureau of Reclamation Facilities
Page, Arizona

STRUCTURES AND IMPROVEMENTS		Orig. Cost
Municipal Office Building		$ 116,001
Garage, Fire Station & Police Building -	$239,612	
Additions -	16,623	256,235
Laboratory (Museum)		67,184
Portable Housing (16 Units)		35,198
Grading Transa-house Area		35,577
Airport --- $322,651		
Additions - 369,579		692,230
Hospital Complex:		
Land	$ 16,913	
Morgue	2,876	
Structures & Improvements	485,860	
Equipment - 6/30/74	72,611	
Nurses' Housing (1 unit)	10,750	589,010
Municipal O & M Shop Building		28,356
Animal Shelter		8,373
Streets, Sidewalks and General Improvements		1,414,633
Estimated value, non-listed streets added to books 5/69		51,600
Water System --- $2,262,721		
Additions --- 1,382,062		3,644,783
Sewage System -- $ 737,472		
Additions --- 32,835		770,307
Administration Building		305,126
Road (Access to Page)		51,209
Law Radio		1,840
Permanent Warehouse		540,302
Oil, Paint and storage building		13,996
Original cost of permanent housing (199 Units)		3,659,336
Less: Disposed of - houses sold to various people		(3,659,336)
TOTAL		$8.621.960

Source: Bureau of Reclamation

FIGURE II-67

Summary of the Town of Page, Arizona
Operation & Maintenance and Revenues

Upper Colorado River Basin Fund

FY	Funded O & M Expense	Less Revenues	Net Funded O & M Costs
1960	494,375	(193,688)	300,687
1961	596,314	(236,656)	359,658
1962	701,216	(325,312)	375,904
1963	803,803	(440,390)	363,413
1964	716,637	(404,507)	312,130
1965	705,470	(325,793)	379,677
1966	485,534	(242,364)	243,170
1967	404,530	(218,553)	185,977
1968	404,599	(219,325)	185,274
1969	383,202	(180,142)	203,060
1970	498,732	(079,463)	419,269
1971	682,059	(172,610)	509,449
1972	544,962	(197,838)	347,124
1973	562,453	(254,839)	307,614
1974	680,087	(326,446)	353,641
TOTAL	8,663,973	(3,817,926)	4,846,047

Source: Bureau of Reclamation

FIGURE II-68

Municipal Operating and Maintenance Expenditures
in Page, per capita

1960	187.69
1961	107.85
1962	126.85
1963	135.78
1964	184.65
1965	380.51
1966	283.28
1967	300.10
1968	290.87
1969	218.97
1970	274.78
1971	209.41
1972	118.21
1973	79.22
1974	75.22

Source: Calculated from Bureau of Reclamation statistics

FIGURE II-69

Municipal Expenditures
Tooele and Brigham City, Utah

	Brigham City (Per Capita) 1969-71 Average	Tooele (Per Capita) 1969-71 Average
General Government	$18.75	$ 5.95
Public Safety	11.65	15.80
Police	8.65	10.50
Fire	1.85	1.90
Public Works	19.50	34.20
Highways	9.60	9.40
Waste and Refuse Collection	3.40	1.60
Sewage	1.33	19.10
Health	.70	.00
Culture, Parks and Recreation	15.25	11.40
TOTAL	$65.85	$67.35

Note: Public utilities are not included.

Source: "Report of Operating Budget for Brigham City," and "Report of Operating Budget for Tooele," 1969-70 and 1970-71. Statistical Review of Government in Utah, 1971, Utah Foundation.

FIGURE II-70

Cost Comparison For Three Towns

Municipal Operating and Maintenance Expenditures	
Brigham City, Utah - 1969-71 (Average)	65.85*
Tooele, Utah ---- 1969-71 (Average)	67.35*
Page, Arizona ----- 1969-71 (Average)	243.39

Transmission system impact area

Introduction

The proposed transmission system would pass through Coconino, Mohave, Yavapai and Maricopa counties in Arizona; Lincoln and Clark counties in Nevada; Kane and Washington counties in Utah; and San Bernardino, Riverside and Orange counties in California. Maricopa County in Arizona and Orange County in California are the areas to be benefited by energy generated at the Kaiparowits plant.

Population

Arizona

The 1970 census revealed a four-county population of 1,078,438, a 45.3 percent increase from 1960, as shown in Figure II-71. This was also about 50 percent of the population of Arizona. About 90 percent of the region's population lives in Maricopa County, mostly in the Phoenix metropolitan area. The rest of the region is sparsely populated. The population density in Coconino, Mohave and Yavapai counties ranges from 2.6 to 4.5 persons per square mile, while the density for Maricopa County is 105.7 persons, as shown in Figure II-72.

The rural-urban distribution pattern is of increasing urban and decreasing rural populations. The regional distribution in 1970 was 89.2 percent urban and 10.8 percent rural as shown in Figure II-73.

Population of the region is projected to increase from about 1 million in 1970 to approximately 1.4 million by 1980. Most of this increase is expected in the metropolitan area of Maricopa County and the urban areas of Coconino, Mohave and Yavapai counties (see Figure II-72). Nearly a quarter of Coconino County's civilian population is Navajo Indians residing on the reservation. Another 44 percent of the population lives in Flagstaff. Population projections indicate that the county will increase to about 79,000 by 1980.

FIGURE II-71

Population of Arizona Counties (1960 - 1973)

County	1960	1970	% Increase	1973*	% Increase
Coconino	41,857	48,326	15.5	59,500	23.1
Maricopa	663,510	967,522	45.8	1,119,400	47.1
Mohave	7,736	25,857	334.2	32,000	23.8
Yavapai	28,912	36,733	27.1	45,500	23.9
Region	742,015	1,078,438	45.3	1,256,400	16.5
State	1,302,161	1,770,900	36.0	2,058,000	16.2

*Population Estimate

Source: 1970 Census

FIGURE II-72

Arizona - Population and Population Projections

Area	Area in Sq.Mi.	1970 (Actual) Population	1970 (Actual) Percent of Region	1970 (Actual) Density Per Sq.Mi.	1980 (Projections) Population	1980 (Projections) Percent of Region	1980 (Projections) Percent Increase	1980 (Projections) Density Per Sq.Mi.
Cocônino	18,540	48,326	4.5	2.6	78,900	5.5	38.8	4.3
Maricopa	9,155	967,522	89.7	105.7	1,267,400	88.1	31.0	138.4
Mohave	13,217	25,857	2.4	2.6	41,900	2.9	62.0	3.2
Yavapai	8,091	36,733	3.4	4.5	50,000	3.5	36.1	6.2
Region	49,003	1,078,438	100.0	22.0	1,438,200	100.0	33.3	29.3
State	114,500	1,770,900	100.00	15.5	2,381,800	100.0	34.5	20.8

Source: U.S. Census

FIGURE II-73

Arizona Rural - Urban Population - 1970

Area	Total	Urban%	Rural %
Coconino	48,326	54.0	46.0
Maricopa	967,522	93.4	6.6
Mohave	25,857	28.3	71.7
Yavapai	36,733	42.9	57.1
Region	1,078,438	89.2	10.8
State	1,770,893	79.5	20.5

Source: 1970 Census

Nearly half of Yavapai County's population is in or near Prescott, and about 30 percent resides in the Verde Valley. The population here is notably older than in the rest of the region as well as in Arizona as a whole. Approximately 17 percent are 65 or older, compared to about 10 percent for the region and 8 percent for the state.

Maricopa County is still growing at a rapid rate. Most of its population is concentrated in the Phoenix area. Phoenix, the state capital, has a population exceeding one-half million people, with another 200,000 to 300,000 living in the surrounding cities. Maricopa County's population is about 1 percent Indian, approximately 3 percent Negro, and a little over 14 percent Spanish extraction. Mohave County's population is concentrated in the Kingman, Lake Havasu City and Bullhead City areas. It has been one of the fastest growing counties in Arizona.

California

A significant change in population trends has taken place in California, especially southern California, in recent years. These are projected on Figure II-74, based on data from the California Department of Finance. Predictions for the southern California counties are that Los Angeles will decline in growth rate with increased out-migration to Orange, Riverside, San Bernardino and other neighboring counties. By the year 2000, the ten-county area will have an increased population of 5 million, of which over 80 percent will be outside Los Angeles County.

Population along the proposed transmission routes is relatively small, especially in towns and cities within 3,000 feet of the line (see Figure II-75).

Nevada

In Nevada, the proposed transmission system would pass through Lincoln and Clark counties. Ninety-nine percent of the two-county region's population is

FIGURE II-74

California

Population and Population Projections

County	Area in Square Mile	1970 Population	Density Per Square Mile	1980 Population	1980 Percent Increase	1980 Density Per Square Mile
San Bernardino	20,154	685,500	34.0	765,100	7.6	37.9
Riverside	7,235	461,200	63.7	596,400	13.2	82.4
Orange	786	1,432,900	1,823.0	1,970,500	15.1	2,507.0
Region	28,175	2,579,600	91.6	3,332,000	13.4	118.3

Source: California Department of Finance: SPNB

FIGURE II-75

California Communities Along Mohave-Serrano
Segment of the Proposed Transmission System

Community	County	Population 1970	1971	1980
Needles	San Bernardino	4,051	4,058	5,100
North Palm Springs*	Riverside	300	350	450
Palm Springs	Riverside	20,636	25,450	29,000
Indio	Riverside	14,459	18,100	24,800
Chiraco Sum.*	Riverside	10	10	12
Desert Center	Riverside	25	25	30
Cactus City*	Riverside	20	25	-
Whitewater*	Riverside	30	31	-
Cabazon	Riverside	598	630	-
Beaumont	Riverside	5,484	5,920	6,620
Banning	Riverside	12,034	13,040	14,600
Menifee	Riverside	480	500	530
Homeland	Riverside	1,650	1,700	1,760
Romoland*	Riverside	350	370	400
Sun City	Riverside	5,850	6,100	6,500
Elsinore	Riverside	3,526	3,970	4,600
Villa Park	Orange	2,640	5,275	7,200
Peralta	Orange	3,800	4,975	6,770

*Localities within 1,500 to 3,000 feet of transmission lines.
Sources: William Kuelbeck and Associates and Riverside County Planning Department (EDAW study).

concentrated in Clark County, with a density of 35 persons per square mile. Las Vegas, about 12 miles from the proposed line, is the largest population center in the region. The population density for Lincoln County is 0.02 persons per square mile. See Figure II-76 for the 1980 projections. Clark County's population increased from 127,016 in 1960, to 273,288 in 1970. This accounts for 56 percent of the state's population in 1970. Tourism, entertainment and recreation linked to the growing southern California population has created this increase. More than 22 million people visited the Las Vegas resort area in 1969. Most of the county's manufacturing activity is in Henderson, 15 miles south of Las Vegas.

Utah

In Utah, the 1970 population of Kane County was 2,418, or 0.6 people per square mile. The 1972 estimated population was 2,700. Kane County's 1980 population projection is 3,000.

The 1970 population of Washington County was 13,669 or 5.6 people per square mile. The 1972 estimated population was 16,000 and the 1980 projection is 25,000.

Employment

Arizona

Based on 1970 data, employment in the four-county region is about 63 percent of the state total. About 382,800 job holders, or 93 percent of the region's employment, are in Maricopa County, mostly in the metropolitan area of Phoenix. Tabular data in Figure II-77 for Coconino, Maricopa, Mohave and Yavapai counties shows employment by section for each county. Unemployment in 1970 was 4.2 percent, for the four-county area, compared to 5.1 percent for the state. Major employment sectors, in descending order of importance for the region, are: trade, manufacturing, services, and government. By comparison, the major employment sectors for the state are: trade, government, services and manufacturing.

FIGURE II-76

Nevada and Utah - Population and Population Projections

County	1970 Population	1970 Density Per Sq.Mi.	Percent Change 1960 - 1970	1972* Population	1980 Population	1980 Density Per Sq. Mi.
			Nevada			
Lincoln	2,557	.02	5.2	2,522	2,909	.02
Clark	273,288	34.7	115.2	297,332	404,533	51.4
Region	275,845	2.2		299,854	407,442	3.2
			Utah			
Kane	2,418	.6	9.2	2,700	3,000	
Washington	13,669	5.6	33.1	16,000	25,000	___
Region	16,087	2.5		18,700	28,000	4.3

*Estimate

Source: U. S. Census

FIGURE II-77

Arizona Employment - 1970

Employment	Coconino Number	Coconino %	Maricopa Number	Maricopa %	Mohave Number	Mohave %	Yavapai Number	Yavapai %	Region Number	Region %	State Number	State %
Total Labor Force	20,675		339,200		9,050		9,975		438,900		689,200	
Unemployment	1,000	4.8	16,400	4.1	600	6.6	500	5.0	18,500	4.2	35,200	5.1
Total Employment	19,675	100.0	382,800	100.0	8,450	100.0	9,475	100.0	420,400	100.0	654,000	100.0
Non-Agriculture	17,125	87.0	325,400	85.0	7,100	84.0	7,775	82.1	357,400	85.0	544,800	83.3
Manufacturing	1,475	7.5	70,400	18.4	825	9.7	850	9.0	430,950	17.7	90,300	13.8
Mining	(D)	(D)	200	.05	(D)	(D)	(D)	(D)	(D) +200	.05	(D) 20,600	3.1
Contract Const.	1,050	5.3	20,700	5.4	850	10.0	425	4.5	23,025	5.4	37,000	5.7
Trans., Comm. & Public Utilities	900	4.6	17,800	4.6	400	4.7	575	6.1	19,675	4.7	30,000	4.6
Trade	3,775	19.2	81,400	21.3	1,575	18.6	1,500	15.8	88,250	21.0	127,300	19.5
Fin., Ins., & Real Estate	(D)	(D)	22,300	5.8	(D)	(D)	(D)	(D)	(D) +22,300	5.4	30,000	4.6
Services	3,525	17.9	54,600	14.3	1,275	15.0	1,150	12.1	60,550	14.4	90,800	13.9
Government	5,900	30.0	50,000	13.2	1,475	17.4	2,225	23.5	59,600	14.1	118,800	18.1
Agriculture	200	1.1	14,400	3.8	200	2.4	600	6.3	15,400	3.7	35,700	5.5
Other	2,350	11.9	43,300	11.2	1,150	13.6	1,100	11.6	47,900	11.3	73,500	11.2

(D) Data withheld, but included in totals
Source: 1970 Census

Agriculture accounts for only 3.7 percent of regional employment. In Yavapai County, however, it is more important as about 6 percent of employment is related to agriculture.

In Coconino County, the livestock industry continues to be an important factor in the economy. Lumbering plays an important part in the economies of Flagstaff and Williams, since these cities are in the nations' largest continuous ponderosa pine forest. Tourism has been important in the county since its early days, and has remained a major economic factor. The Snow Bowl (skiing facility on Humphrey's Peak), Indian ruins, the ponderosa forests, Meteor Crater, Navajo trading posts, Oak Creek Canyon and the annual Indian pow-wow in July attract thousands every year. The economy of the county is based on the following industries: government, retail trade and services, tourist activity and travel, manufacturing, and contract construction. Employment in the service industry has not only kept pace with overall economic growth, but has well exceeded the rate of increase in total employment. In 1960, the service industry represented 6.4 percent of total employment. In 1970, this segment rose to almost 18 percent of the total employment. A large part of this increase can be attributed to employment in Navajo tribal enterprises and especially to tribal nonprofit programs. Large numbers of Navajo youth are employed in these programs during the summer months. Still the average annual per capita income in reservation areas which would be crossed by the proposed transmission lines is $804, well below state and national averages. Trade is the second largest employer in the county, using more than 19 percent of the total labor force, and supported to a large extent by tourism. Government is the largest employer in the county, engaging 30 percent of the total labor force. It is also the leading contributor in earnings, with over 25 percent of the total.

Unemployment shows clear seasonal variations due to the effect of high-plateau winter weather on outdoor activities. Seasonal variations in lumbering,

wood products, processing and construction activities contribute substantially to variations in employment. Tourist activity (retail trade and services) also declines significantly during winter, thereby reducing the demand for workers in motels and restaurants. Unemployment is, therefore, highest in winter (January through March) and lowest in late summer and fall (August through November). Unemployment on Navajo, Hopi, Kaibab, Hualapai, and Havasupai reservations is at least three times higher than over the rest of the county. This is due mainly to the large supply of low-skilled labor which far exceeds present demand.

In Yavapai County, mining, ranching and governmental activities have been the economic base for many years. Mining is still an important factor, although decreasing in recent years. The range-cattle industry has had a lasting effect on the economy, providing income and livelihood for many small communities. Light manufacturing is taking an increasingly important role in the county economy, as several small manufacturing concerns are operating in Prescott and Cottonwood. Yavapai County's principal source of agricultural income is from its approximately five million acres of rangeland. Some 200 commercial cattle ranches produce, annually, more than $6 million worth of beef cattle. This is 86 percent of the agricultural income of the county. There are approximately 82,000 head of range cattle in Yavapai and cattlemen produce about 32,000 head of good to fancy feeder calves for sale annually. In addition, some 7,000 head of feeder yearlings are offered for sale. There are about 1,200 head of dairy cattle in nine commercial herds.

Approximately 23,500 acres of irrigated farmland are tilled. Principal field crops, in descending order of importance, are: alfalfa, corn, small grains, vegetables and fruits. The service industry is the third largest employer. It contributes approximately 31 percent of the county's total earnings. A large part of this employment and income is directly related to retirement and tourist sectors.

Nearly 1,500 workers are engaged in wholesale trade in Yavapai County. This industry also accounts for about 10 percent of total earnings. More than 9 percent of Yavapai workers are in manufacturing. Production of apparel, cement machinery and miscellaneous manufacturing contributes significantly to the export of goods from the county. More than 6 percent of earnings is contributed by this sector. Nearly 25 percent of employment is government related. A Veterans Hospital and two national forests account for the relatively high federal employment. Yavapai County's most significant manpower problem now is the lack of jobs. Because of this there has been a significant out-migration of young people of work-force age.

Maricopa County has a diversified economy, independent of any single firm or industry. Major sources of income are manufacturing, agriculture and tourism. Phoenix is the fastest growing regional market in the United States. It is also becoming a prime financial center for the western states. Agriculture has historically been a major component of the county's economy since Maricopa has about 38 percent of Arizona's cultivated cropland. Agricultural employment has been slowly declining since 1950, however, due to increased mechanization and consolidation of farms into larger, more efficient units.

The service industry, which includes tourism, is a major contributor to the county economy. In 1970 this sector employed 54,600 people or more than 14 percent of the employment population. It also contributed almost 13 percent of the county's earnings during the same period. The trade sector is the largest employer. More than a fifth of county employment in 1970 was in wholesale and retail trade activities. It was also the largest contributor in earnings with more than 14 percent of total earnings coming from this sector. Manufacturing employment more than doubled in Maricopa County from 1960 to 1969; however, defense and aerospace cutbacks, plus a general economic slowdown, caused sizeable losses in manufacturing employment in 1970. It is still, however, one of the

largest employers in the county. Population growth has been the major stimulus to growth in the government sector. Government is the third largest employer in the state. Job holders are both local government and federal employees, and many are involved in education. Only 4.1 percent of the employment force was unemployed in 1970, compared to 5.1 percent for the state as a whole.

Employment in Mohave County centers around mining, wholesale and retail trade, government, and services. In 1970 mineral production reached $41 million. Because of its recreational attractions (Lake Mead, Lake Mohave, Colorado River, Grand Canyon and the London Bridge) about 40 percent of the county's work force is employed in recreational and tourist enterprises. This activity is reflected in the retail trade, services and governmental sectors. Unemployment is higher in Mohave County than in Yavapai, due to the seasonally-oriented tourist activity, and is possibly stimulated because the county had the highest in-migration rate of any county in the United States during the 1960-1970 period.

California

Employment in southern California has been good in recent years. Orange County now records the lowest unemployment level since 1969. Statistics for Riverside and San Bernardino counties reveal recent increases in rate of employment and total work force, and a drop in the unemployment rate from 7.3 percent in 1972 to 6.8 percent in 1973 (Security Pacific Bank Research Department, 1974). A picture of the employment situation in this region is given in Figure II-78.

FIGURE II-78

Tri-County Employment and Unemployment

	Total Employment 1970	Unemployment 1970	Employment 1972	Unemployment 1972
Orange County	539,000	38,000	591,000	39,800
Riverside County	360,500	22,700	380,200	23,900
San Bernardino	379,000	30,000	408,000	32,000

In the area of the proposed transmission line, employment possibilities are limited to service and maintenance, transportation, communication, utilities-oriented work, mining and associated industrial work and agriculture. Service-related work is strongly related to tourism in this area.

Nevada

Based on 1973 employment data, total employment in the potentially affected Nevada and Utah counties is shown in Figure II-79. Approximately 125,000 persons, or 95 percent of the region's employment, are in Clark County, Nevada, with the majority concentrated in the Las Vegas area. Major employment sectors for the four-county region are: trade, government, services, and manufacturing. Agriculture accounts for only a small percent of employment. Lincoln County, Nevada, is sparsely populated and has a small employed force of 710 people. Of those, 38 percent or 270 people are government employed, 14 percent are in agriculture, and 11 percent are in mining. This county has the highest unemployment rate in the four-county region. Clark County provides employment in the entertainment, tourism, recreation and services categories. Its stability is linked to the nearness of the huge southern California population centers. More than 22 million persons visited Las Vegas in 1969. Industrial employment is concentrated in the Henderson area, south of Las Vegas.

FIGURE II-79

Utah and Nevada Employment - 1973

Type of Employment		Lincoln County, Nevada Number	Lincoln County, Nevada Percent	Clark County, Nevada Number	Clark County, Nevada Percent	Kane County, Utah Number	Kane County, Utah Percent	Washington County, Utah Number	Washington County, Utah Percent
Service	57,160	60	8.4	51,000	41.0	167	16.0	533	10.1
Trade	28,411	100	14.1	20,700	16.5	194	18.5	1,242	23.3
Government	26,089	270	38.0	16,200	13.0	212	20.1	1,132	21.3
Construction	12,033	10	1.4	7,400	6.0	0	0	448	8.4
Transportation	10,171	80	11.3	7,300	5.9	0	0	91	1.7
Manufacturing	7,342	10	1.4	4,300	3.5	73	6.9	409	7.7
Finance	5,196	0	0	4.200	3.4	0	0	146	2.8
Agriculture	4,429	100	14.1	3,000	2.3	74	7.0	380	7.2
Mining	1,555	80	11.3	1,000	.8	0	0	0	0
Other	13,433	0	0	9,600	7.6	330	31.5	928	17.5
Total Labor Force		820		133,900		1,219		5,579	
Unemployment		110	10.7	9,200	6.7	169	5.8	270	5.1
Total Employment		710		124,700		1,050		5,309	

Source: 1970 Census

Utah

Employment in Kane County, Utah, is based on agriculture, lumber production, tourism, movie making and light manufacturing. The 1970 statistical reports from the Utah Department of Employment Security do not reflect the importance of mining in the county. However, it is because of extensive coal deposits in eastern Kane County's Kaiparowits Plateau that this region is being studied. Tourism and government are principal economic factors in Washington County. In the southwestern corner of Utah, Washington County was dubbed "Utah's Dixie" by the Mormon pioneers because of its warm summers and mild winters. St. George has the county's largest employment with a population in excess of 10,000, and is adjacent to the Interstate 15 route from Las Vegas to Salt Lake City. Many motels, restaurants, shops and a Mormon temple attract and accommodate a large tourist clientel.

Standard of living

Arizona

In Arizona, Maricopa County supplies most of the personal income in the four-county Arizona impact area. More than $3 billion, or about 92 percent of the total income for the four counties, is produced in this area. Most of this income is generated in the urban areas of the county as shown on Figure II-80.

Per capita income for the region is $2,930. Per capita income and the disposable income per household are both considerably higher in Maricopa than in Coconino, Mohave, or Yavapai counties. Thirty-six percent of the households in Maricopa County are in the $12,000-and-over income category and only 18.3 percent are below $5,000. These figures are considerably better than the averages for Coconino, Mohave, or Yavapai counties, or the state as a whole. In summary, the rural areas of the region and the Indian reservations have a higher percentage of families within the lower groups than do the metropolitan areas.

FIGURE II-80

Arizona
Personal Income (1970)

County	Total Personal Income ($000)	Per Capita Income	% Families Under $5,000	% Families Over $12,000	Mean Family Income	Percent Receiving Assistance
Coconino	126,370	$2,552	24.4	25.2	$ 9,600	5.6
Maricopa	3,332,671	3,498	18.3	36.0	11,289	3.7
Mohave	67,700	3,073	22.8	30.7	9,875	3.2
Yavapai	93,861	2,579	31.0	20.0	8,332	2.6
Region	3,620,602	2,930	24.1	28.0	9,774	3.8

Source: 1970 Census

California

A report of March 1970, by the Security Pacific National Bank Research Department states, "currently, southern California ranks third in total personal income behind California and New York. Southern California also accounts for more than half (58.8 percent) of California's total personal income of $76,581,000,0 . . ." The report continues that 50.8 percent of the state's total comes from these five southern counties: Los Angeles, Orange, Riverside, San Bernardino and Ventura. It also states that the average annual increase in total personal income in southern California between 1960 and 1968 was 8.6 percent. An example of personal income growth since 1968 is shown in Figure II-81.

FIGURE II-81

Personal Income

(millions of dollars)

County	1969	1970	1971	1972	
Orange	5,477.0	5,968.3	6,291.2	6,971.0	Estimate
Riverside	1,485.6	1,626.8	1,771.5	1,950.0	
San Bernardino	2,121.0	2,366.3	2,721.0	2,955.0	Estimate

*Millions of dollars

The standard of living of residents along much of the proposed transmission route is somewhat lower than is reflected in the above statistics, since the route passes many retirement communities, and some areas inhabited by farm laborers.

Nevada

In Nevada, most of the total personal income is earned in Clark County. Nearly a billion dollars, or 99 percent of the total income for the four-corner

FIGURE II-82

Nevada and Utah Personal Income (1970)

State	County	Total Personal Income ($000)	Per Capita Income	Percent Families Under $5000	Percent Families Over $12,000	Mean Family Income	Percent Receiving Assistance
Nevada							
	Lincoln	6,535	2,556	33.2	38.4	8,864	21.9
	Clark	969,079	3,546	14.4	42.6	10,870	11.9
Utah							
	Kane	6,331	2,387	18.8	20.7	7,287	17.4
	Washington	35,507	2,102	31.3	16.8	6,948	10.3

Source: 1970 Census

region comes from Clark County (see Figure II-82). Highest per capita income and disposable income is in Clark, while Lincoln County is much lower. Other than the higher earnings resulting from tourism in Clark County, the communities which would be influenced by the proposed powerline enjoy a moderate standard of living with few extremes. There is very little extreme poverty while, at the same time, there are few wealthy persons. Approximately 42.16 percent of the households in Clark are in the $12,000-and-over income category, while 14.4 percent are under $5,000. Lincoln County has the largest percentage of families receiving financial assistance.

Utah

Total personal income for the counties which would be crossed by the proposed transmission lines is shown in Figure II-82. In general, personal and family incomes are higher in Kane County than in Washington County. As in Nevada, the area has a moderate-to-low standard of living, with few extremes. Communities near the proposed transmission line routes exhibit the historic Mormon frugality which tends to negate poverty. These southern Utah counties lack heavy producers of large income, such as mining, finance, manufacturing, and construction.

Housing and services

Arizona

Figure II-83 reflects the housing situation in the Arizona four-county region. In 1970, there were more than 360,000 houses in the area. Over 90 percent were occupied, either by owners or renters. Most of these met basic housing standards as only 9.3 percent lacked plumbing. Mohave and Coconino had the highest percentage of substandard homes, with 15 percent without complete plumbing facilities. In Page (Coconino County) most homes are of the "mobile" variety. This community was created during construction of Glen Canyon Dam, but

FIGURE II-83

Arizona Selected Housing Characteristics

	Coconino	Maricopa	Mohave	Yavapai	Region	
Total Housing Units	14,808	318,714	10,550	16,136	360,208	
% Housing Units Lacking Plumbing	15.3	2.5	12.9	6.6	9.3	
Owner Occupied	6,900	200,737	6,287	8,879	222,803	
Renter Occupied	5,574	101,896	2,339	4,120	113,929	
For Sale Only	80	1,853	126	321	2,380	
Median Price Asked	$15,500	$18,400	$18,300	$14,600	$16,700	
For Rent	520	8,251	392	494	9,657	
Median Rent Asked	$ 77	$ 119	$ 139	$ 53	$ 97	(average)
Other Vacant	1,734	5,977	1,900	2,322	11,933	

Source: 1970 Census

most of the inhabitants are now employed at the Navajo power plant. For services, refer to the employment section.

California

Figure II-84 shows the housing situation of California communities near the proposed transmission routes. Data were taken from the Study contracted by Southern California Edison (Appendix I-13), with source data from Williams-Kuebelbeck and Associates. Communities in the Mohave Desert tend to have smaller houses, with the exception of the city of Needles. From the Coachella Valley west, housing is similar to that in the more densely-populated urban areas. In general, the same pattern is revealed in services found along the proposed transmission system. The exception is automotive services, which seem to be of higher quality in the desert.

Nevada

Figure II-85 describes housing in the Nevada impact area. Again, the proposed line runs through the most sparsely-populated areas, while census figures are county-wide. In 1970 there were 88,520 houses in the area. Most of these meet basic housing standards and have plumbing.

Utah

As shown on Figure II-85, a significant difference between Kane and Washington counties is in the number of houses having air conditioning. As in Nevada, the proposed transmission route passes through sparsely-populated areas.

Taxes and government

Arizona

Figure II-86 shows assessed property valuation for three counties in the region. It also shows the percentage of assessed valuation taxable in 1971.

FIGURE II-84

California - Selected Housing Characteristics

				HOUSING			
		Population		Occupied Stock		Dominant Structural	Average
Community	County	1970	1974	1970	1974	Type	Condition
North Palm Springs	Riverside	300	350	95	115 (6/73)	Single Family	Fair/Good
Palm Springs	"	20,636	25,450	12,433	16,104	Single Family/ Mobile Home	Good
Indio	"	14,459	18,100	4,405	7,709	Single Family	Good
Chiraco Summit	"	10	10	4	4	Mobile Home	Poor
Desert Center	"	25	25	10	10	Single Family	Moderate
Needles	San Bernardino	4,051	4,058	1,414	1,420	Single Family	Moderate
Peralta Hills	Orange	3,800	4,975	1,150	1,515	Single Family	Good
Villa Park	Orange	2,640	5,275	825	1,345	Single Family	Good
Elsinore	Riverside	3,526	3,970	1,600	1,800	Single Family	Fair
Sun City	"	5,850	6,100	2,930	3,050	Mobile Home	Good
Romoland	"	350	370	120	125	Mobile Home	Fair/Good
Homeland	"	1,650	1,700	550	570	Mobile Home	Fair/Good
Menifee	"	480	500	160	170	Mobile Home	Fair/Good
Banning	"	12,034	13,040	4,460	4,830	Single/Multi	Good
Beaumont	"	5,484	5,920	2,030	2,190	Single/Multi	Good

Source: U.S. Census

FIGURE II-85

Nevada and Utah - Selected Housing Characteristics

State	County	Total Households	% Lacking Plumbing	% With Air Conditioning	% With One or More Cars	Income Less Than Poverty Level
Nevada						
	Clark	87,728	1.6	74.5	92.8	4,827
	Lincoln	792	10.6	24.1	84.1	73
		88,520				
Utah						
	Kane	710	3.9	23.7	90.	102
	Washington	3,834	5.0	82.4	84.5	680
		4,544				

Source: 1970 Census

FIGURE II-86

Arizona Assessed Value of Property - 1971 ($1,000)

	Gross Assessed Value			Tax Exempt		Assessed Value After Deduction of Exemptions					Percent of Assessed Value Subject to Tax		
		Locally Assessed Property					State	Locally Assessed Property			State	Locally Assessed	
	Total	Real	Personal	Real	Personal	Total	Assessed	Total	Real	Personal	Assessed	Real	Personal
Coconino	118,479	43,453	9,183	827	22	117,630	65,843	51,787	42,626	9,161	56.0	36.2	7.8
Yavapai	100,106	46,757	6,680	1,345	119	98,642	46,669	51,973	45,412	6,561	47.3	46.0	6.7
Maricopa	1,410,143	1,046,310	136,470	24,519	434	1,385,190	227,363	1,157,827	1,021,791	136,036	16.4	73.8	9.8

Source: U.S. Census

Federal, state and Indian lands along the proposed route and its alternatives have a great influence on taxes and government. About 20 percent of the land crossed by the proposed route is federally owned, while the remainder is Indian, state and private (see Figure II-87).

Navajo tribal government is established according to regulations prescribed by the Secretary of the Interior under terms of the Navajo Treaty and Congressional acts. It is governed by a 74-member council elected from precincts on the reservation. Executive officers include the chairman and vice-chairman, both elected at large. Council members serve 4-year terms. Voter turnout is normally high. Council members meet regularly. The council works directly with federal and state agencies on such concerns as health, education and the standard of living.

The Hopi Tribe is governed by the Hopi Tribal Council, in Oraibi, Arizona. Chairman, Vice-chairman and village representatives serve 4-year terms. The council meets quarterly. Emergency sessions are called when necessary. Hopi society is a clan system. Each village is independent of the rest and has either a village chief (a hereditary position) or a governor elected by popular vote. Village leaders oversee settlement of estates, grants of land use privileges for farming or construction of dwellings, and similar matters.

Several federal agencies have some responsibility in the region. The Bureau of Indian Affairs has a trust relationship to the Indians. This influence also extends to the internal finances of school districts. The Forest Service administers the Kaibab, Prescott, Tonto and Coconino national forests. It coordinates timbering, grazing, hunting and recreation activities in these forests. The Bureau of Land Management administers several parcels of national resource land along the proposed route and alternatives. This agency is responsible for multiple use management.

FIGURE II-87

Arizona Land Ownership

Area	Total Area (mi^2)	Ownership Federal (mi^2)	(%)	State (mi^2)	(%)	Indian (mi^2)	(%)	Private (mi^2)	(%)
Coconino	18,600	7,440	40	1,674	9	6,882	37	2,604	14
Yavapai	8,095	3,724	46	1,781	22	81	1	2,509	31
Mohave	13,217	9,642	73.1	674	5.1	872	6.6	2,779	21.0
Maricopa	9,253	4,719	51	740	8	1,481	16	2,313	25
Region	59,165	25,525		4,869		9,316		10,205	

Source: 1970

The Transmission Line Siting Committee of the Arizona State Corporation Commission approves routing of power-generating facilities and transmission lines. The State Land Department controls right-of-way privileges over state-owned lands.

Coconino, Yavapai, Maricopa and Mohave counties do not have direct jurisdiction over power facilities, but do receive revenues from taxes on transmission systems within their boundaries.

California

Figure II-88 shows land ownership in San Bernardino, Riverside and Orange counties, through which the proposed transmission line would pass. This also displays the tax base. Detailed analysis by counties reveals that much residential and industrial development in both Riverside and San Bernardino counties is in the extreme western portions, within the so-called Los Angeles basin area. Thus, along the proposed transmission corridor through San Bernardino County, about half of the land is federal and the rest is owned mainly by Southern Pacific Land Company. (There would be about 63 miles of BLM right-of-way in this county).

In Riverside County there is a higher percentage of private land with large agricultural areas. However, the proposed line would cross national resource land in the desert, as it angles northeast-southwest through Coachella Valley. As the proposed line nears Devers substation, it would leave public land and, except for a few small areas, remain on private lands into Valley and Serrano substations. An exception is a 4-mile segment across the Morongo Indian Reservation. (There would be about 42 miles of BLM right-of-way in this county.)

In Orange County, public land amounts to 11 percent of the total and most of this is in Cleveland National Forest (There are about 6 miles of right-of-way on Cleveland National Forest in this segment).

FIGURE II-88

California Land Ownership

	San Bernardino County Acres	%	Riverside County Acres	%	Orange County Acres	%
FEDERAL						
BLM Public Land [a]	6,977,308	54.1	1,666,941	36.0	1	
Reclamation Withdrawal	70,466	.5	49,821	1.1	0	
Military Reservation[b]	1,840,307	14.3	121,216	2.6	6,000	1.2
National Forest [c]	432,345	3.4	256,798	5.6	51,328	10.2
National Monument [d]	153,450	1.2	446,246	9.6	0	
Indian - BIA - Trust, etc. [e]	61,502	.4	128,708	2.8	0	
Total Federal	9,535,378	73.9	2,669,730	57.7	57,329	11.4
STATE						
A. State Lands Commission [f]	245,200		56,251		0	
B. Parks and Recreation [g]	4,265		23,515		249	
Total State	249,465	1.9	79,766	1.7	249	
PRIVATE						
1. Railroad [h]	859,040	6.7	92,800	2.0	0	
2. Other [i]	2,254,677	17.5	1,788,272	38.6	445,462	88.6
Total Private	3,113,717	24.2	1,881,072	40.6	445,462	88.6
COUNTY TOTALS	12,898,560		4,630,568		503,040	

[a] Includes all public lands under BLM jurisdiction such as - Public Water Reserves; Nat'l Coop. Land & Wildlife Management Area Withdrawals; Special Withdrawals; #15 Recreation W/D (Mecca Hills); Temporary W/Ds by E.O.s upon determination and classification for inclusion in Nat'l Monuments (various); Desert Land Entries; Riverside District BLM Proposed Legislation.

[b] Includes all public lands withdrawn for military purposes (Dept. of Defense) and other military reservations on acquired lands (Army, Navy, Air Force).

[c] Includes only public lands and acquired lands (net) within National Forests administered by U. S. Forest Service, USDA.

[d] Joshua Tree N.M., Death Valley N.M., and Cabrillo N.M.

[e] Indian Reservations under Bureau of Indian Affairs; includes trust lands, tribal, and individual, from Riverside District BLM Records, and Riverside BIA office.

[f] From Riverside BLM Office list of State Grant lands distributed by the State Lands Commission.

[g] State lands administered by the State of Calif. Dept. of Parks and Recreation (includes State Beaches and Parks), from Calif. Statistical Abstract, 1967.

[h] Railroad land grants administered by the Southern Pacific Land Department, from Southern Pacific Lands in California" ownership maps - Riverside BLM District Atlas.

[i] Other private lands also includes small areas of county and city land.

Source: BLM records

The Bureau of Indian Affairs exercises land use control, working with several Indian tribes in Coachella Valley. The Forest Service is directly involved with the proposed line (Cleveland National Forest) and indirectly with the line where it would be visible from San Bernardino National Forest in the Banning Pass area. The National Park Service is directly involved as the proposed line would pass immediately adjacent to Cottonwood entrance to Joshua Tree National Monument.

The State Public Utilities Commission has jurisdiction over power siting and transmission lines. The State Land Department controls right-of-way grants on state-owned lands. The State Resources Agency has some jurisdiction over resource values such as wildlife, vegetation and minerals.

County planning departments have no direct jurisdiction over transmission lines, but contribute to environmental analyses at public hearings and agency meetings.

Nevada and Utah

Tax data is displayed for Lincoln and Clark counties, Nevada, and Kane and Washington counties, Utah, in Figure II-89. Nearly the same conditions exist for these governmental authorities as were described in the Arizona and California subsections.

Culture and attitudes

Arizona

The proposed transmission line would cross the western part of the Navajo Reservation, largest and most populous in the United States, with nearly 130,000 residents. People are widely scattered through the reservation. In the two western districts crossed by the proposed transmission routes, there are about 10,800 people in families ranging from 6.3 to 8.7 people. Throughout history, Navajos have preferred a pastoral way of life but a transition is now

FIGURE II-89

Nevada and Utah - Taxes and Government

				Property Taxes		Government Employment		
State	County	Total General Revenue (Millions)	% of Revenue from other Governments	% of Total Revenue	Per Capita	Federal	State, City & County	1968 Voters
Utah	Kane	$ .8	39.6	43.3	$160	42	170	1,135
	Washington	3.2	50.3	27.9	60	119	1,103	5,000
Nevada	Lincoln	1.2	58.5	30.6	136	26	244	1,113
	Clark	88.2	31.4	46.6	139	3,492	12,708	75,065

Source: County and City Data Book - 1972

taking place to a wage economy, with younger people moving into communities where jobs are available. Population concentrations are now largely in livestock operations, and are found near developed communities, trading posts and government installations. Younger family groups also appear to be moving nearer developed roads and into newly-developed, low-rent and self-help districts.

Navajos are notable for their ability to adjust to new situations and benefit from the contact on one hand without losing their identity on the other. From the Pueblo people, they learned of agriculture and weaving and borrowed numerous religious ideas and motifs that they put to use in their own way. Equally profound was the change that occurred when the Navajo adopted livestock grazing as a basic economic activity. Changes effected as a consequence of animal husbandry were perhaps the most important since the keeping of herds created new relationships to the environment that had to be recognized in social structure, personal behavior and even values. Despite these changes, the Navajo people did not lose a sense of continuity and identity. Through several centuries of almost continuous contact with various foreign cultures, they have selected only those aspects of other cultures which fitted most easily into Navajo life.

Today, non-Navajo culture impinges so incessantly that it is virtually impossible to remain unaffected. Increase of the Navajo population has filled the reservation and made it impossible for the majority of the Navajo to make a living by traditional means. Radios, increased literary interest, television, motion pictures, and experiences in off-reservation employment have created new aspirations. Advantages of a truck over a wagon, or a stove over an open fire are constantly seen by the Navajo. Old ways in material terms may have no attraction for them as symbols of Navajo life. There is a tendency, however, to apply Navajo practices to new material contexts. Thus, it is commonplace to see

a modern Navajo wearing a cowboy shirt and boots, while driving a powerful new pickup truck with an eagle-down tied to the rear view mirror (eagle-downs were carried by Navajo runners and horsemen to assure speed and endurance). Same pride of ownership and display once expressed by keeping a large herd of horses is now found in assembling all trucks and automobiles in a homestead group and then arriving in a caravan to park near the trading post.

As with many Indian people, Navajo cultural and religious concepts are also based upon respect for, and in harmonious relationship with nature and the earth. Traditional Navajos regard the earth as their mother, giver of life and provider of natural resources which enable them to live. Their belief is that resources so provided are to be protected or utilized for the benefit of inhabitants of the land. These resources are not to be used in a wasteful and extravagant manner. They also believe that the earth should be retained in its natural condition or restored after use, where possible.

Most important is the attitude of the Navajo about himself. He wants to be considered as an individual, free to choose his own lifestyle. He wants to be an equal among others and he is repelled by the "do-gooder" who wants to protect (preserve) him and his heritage as well as the unscrupulous who would cheat and steal from him. Briefly, he wants to chart his own destiny with respect and without outside influence. This attitude is shared by other Indian nations.

The Hopi Reservation is in the Colorado Plateau area of north-central Arizona, within the administrative boundary of the Navajo Reservation. The proposed transmission line would pass through an area of disputed ownership between the two Indian tribes since both groups are claiming ownership. The Hopi are Pueblo Indians who, as city builders and dwellers, have attained a high degree of social sophistication. They are businesslike in their dealings,

industrious, have a high regard for modern education, and are quite religious. The Hopi religion centers around the Kachina, a variety of god-like entities which aid and assist the Hopi throughout their lives. In terms of modern-day living, almost all Hopi practice or participate in religious rites consisting of dances and ceremonies which concern the aspects of their everyday life. The Hopi are divided into traditional and progressive factions, with traditionalists opposed to any change from the old ways and progressives pursuing modern methods of transportation, communication, education and living.

Tribal lands held in trust by the United States are not subject to procedures for public right-of-way acquisition. Consent of tribal governing bodies must be obtained, prior to a grant by the Secretary of the Interior of rights-of-way across such lands. Negotiations between the tribes and utility interests are usually necessary before consent is granted.

The proposed line will pass through a wide variety of vacant and sparsely-populated areas. Most residents of these areas are engaged in ranching or other outdoor activities. But, as in other parts of the state, the younger people have tended to leave the rural areas for better job opportunities in urban areas. Urban areas with a varied economic base (government, manufacturing, tourism, retail trade) have continued to expand while small or one-industry towns have lost residents. On the whole, the state is growth and development oriented.

In Phoenix and adjacent areas, there is a wide variety of occupational possibilities. Many people commute 30 to 40 miles daily to maintain a rural home life and still enjoy city employment opportunities. In Phoenix, the variety of life styles is too diversified to describe.

California

The proposed line would go through about 5 miles of the Morongo Indian Reservation, and roughly 2 miles of the Agua Caliente Reservation. The right-of-way is through a rugged primitive area, with a state scenic highway between

Banning and Idyllwild. In the past, the Morongo Indians have been reluctant to grant such rights-of-way, but allowed a 220-kV tower line several miles north of this proposed route for one alternate Devers-Valley substation line.

Most desert dwellers in southern California have moved away from large population centers because of overcrowding, traffic conditions, smog, or simply to "get away from it all." They are jealous of their unobstructed views, clean air and simple desert life. Air pollution, visual pollution, noise pollution and other infringements stir up a hornet's nest, often with surprising results. In 1969, the preferred route for a transmission system from Mohave to Devers was to pass through Twenty-nine Palms and Morongo Valley. A relatively small group of interested citizens caused this preferred line to be set aside in favor of the Ward Valley route. These same attitudes are prevalent today.

Nevada

Religious, political and cultural attitudes in Nevada parallel those in Arizona. The state is growth oriented. Henderson is the chief industrial community. Facilities used to produce magnesium during World War II are now used for chemical production and related industries. Las Vegas is the largest city. A prominent tourist attraction with its famed strip hotels, it is also the site of the University of Nevada. Nellis Air Force Gunnery and Bombing School is in nearby North Las Vegas. Mesquite and Bunkerville are pioneer Mormon communities. Unusual architecture of an early era is still in use.

Utah

The attitude of Utah residents is greatly affected by special cultural and religious beliefs in the areas through which the proposed transmission lines would pass. Individual (personal) industry is the rule. Mild winters make St. George a popular winter resort. Tourism and light manufacturing provide an economic base. Hurricane is a rural, basically Mormon agricultural community.

Kanab, seat of Kane County, is a recreation-oriented community between Bryce Canyon, Zion and Grand Canyon National Parks. Scenic backgrounds are frequently used in western motion pictures.

Limestone quarry impact area

Some of the socioeconomic conditions in the limestone quarry impact area are considered in the Socioeconomic section, Kaiparowits Plateau impact area.

The town of Antimony, with a population of 113 (1970 census), lies at the foot of Johns Valley, about 30 miles north of the proposed quarry site, and was not specifically cited in that section. It is typical of other small towns in the area.

Widtsoe, about 6 miles northeast of the proposed quarry site, was a successful agricultural town of 1,110 people in 1920. Drought conditions forced the residents to leave and today only several old abandoned buildings remain. Several farms operate nearby. Thirteen and one-half miles north of Widtsoe and about 8 miles south of Antimony is another agricultural ghost town called Osiris.

Bryce Junction is located just south of the quarry on State Highway 12. There are several motels, restaurants, gas stations, and stores there.

<u>Market area</u>

Environment of the market area is related to the study of market-area impacts; therefore, the complete study is in Chapter III under Impacts in the Market Area.

PROBABLE FUTURE ENVIRONMENT WITHOUT PROJECT (TRENDS)

Kaiparowits Plateau impact area

The probable future environment, if proposed development does not occur, is discussed with reference only to the Kaiparowits Plateau and areas which would be directly affected by the proposed project.

The purpose of this section is to briefly describe the probable future environment, without the project, as a basis for comparing the impacts that would occur if the proposal were implemented. These impacts are discussed in the following chapters.

Three scenarios are briefly described as future alternatives if the proposed project does not take place. They are based on two contrasting possible courses of action: energy resources would not be developed in the area, and present activity would continue more or less unaltered; the large coal reserves in the impact area would be utilized to strengthen the current national energy situation and the trend to develop domestic coal reserves. If the coal reserves were to be exploited, policy decisions may or may not permit coal burning in the area. Consequently, two alternatives are possible: coal mining only, and coal mining plus coal utilization in the area.

It is possible that coal could be shipped out of the area and also burned in local generating or gasification plants. Several scales of exploitation could occur, ranging from a single small mine to several large mines and plants. However, in order to simplify the comparison, the description of possible future alternatives is confined to large-scale coal mining and construction of a single generating plant.

The intention in each scenario is to generally describe what would be added to the Kaiparowits Plateau, rather than to discuss possible impacts in detail. These impacts would vary considerably with the type and location of activities.

Without the development of energy resources

If energy resources in the Kaiparowits impact area are not used, the natural processes and conditions of south central Utah should continue with little alteration. The resident population would not change significantly. Livestock grazing and the minor utilization of wood and mineral resources would continue. State Government has considered constructing one or more all-weather, north-south highways through or adjacent to the Kaiparowits area. This would encourage tourist activity. Recreation may increase in any case, however, depending on gasoline availability. The city of Page, Arizona would continue to decline in population to about half its 1972 size, and many available services there would be under-used or forced to close.

Mining and export of coal without construction of coal-using plants in the Kaiparowits area

Approximately 220,800 acres of land in and adjacent to the Kaiparowits Plateau are currently under coal lease, prospecting permit, or competitive lease applications. There are 12 holders of leases and prospecting permits in the Kaiparowits area. In addition, more than 40,000 acres are under state lease. Major lessors and permittees are Resources Company, El Paso Natural Gas, Consolidation Coal Company, Peabody Coal Company, Sun Oil Company, Del Coal Incorporated, Woods Petroleum, J. H. Knight, and Hiko Bell Mining and Oil. Total reserves of coal are estimated to be approximately 15 billion short tons (Doelling and Graham, 1972). Coal could be shipped out by rail, truck or slurry pipeline. No definite proposals for "mining only" have been made, so the possible schedule and extent of development of major leases are unknown.

With the exception of a small area west of Escalante, coal in the Kaiparowits Plateau is minable only by underground methods which require a larger work force than surface mining. At least 3,000 to 4,000 miners would be employed if minable coal reserves were exploited at the rate of 12 million tons annually.

A population increase of as much as 15,000 in Kane and Garfield counties and Page, Arizona could occur. There would be commensurate requirements for space, water, mineral resources, and an expanded and improved road system. If an access road were constructed from U.S. 89, some miners would probably live in Page.

Mining and construction of coal-fired plants other than Kaiparowits

Proposals have been made for a coal-fired generating plant south of Escalante, Utah, which might ultimately generate 2,000 MW. Accurate assessment of the future environment in Kane and Garfield counties, should this plant be built, cannot be made until a detailed proposal is made. However, a general estimate of changes can be based on the assumption that 8 million tons of coal would be mined annually. About 52,000 acre-feet of water would be stored, and 24,000 to 30,000 acre-feet would be used each year for generating station cooling. At least 4,000 acres of land would be occupied. The population increase, which would be mostly or entirely in Garfield County, could be 3,000 to 5,000 people. Page might not be affected, because it would be more than 80 miles by road from the site.

Environmental impacts would be felt in the Escalante area, about 30 miles north of Fourmile Bench. The impacts would differ from those predicted for the Kaiparowits project, because of differences in location and conditions.

An unknown number of miles of new roads, electric transmission lines, and pipeline routes would be required, as well as several hundred thousand tons of clay, aggregate, and limestone. New industry might be started, and could attract more residents with needs for additional services.

Transmission system impact area

If the proposal is not approved, the environment will not change as a result of this proposal. However, if growth of the Southwest region continues as it has in the past two decades, the demand for electrical energy will increase. If demand increases as expected, there is a potential for increasing power output at the Navajo plant. This would require construction of an additional powerline from the Navajo plant to the urban areas it serves. This action could then create impacts similar to those expected from the proposed action.

New projects, now under consideration, which would put transmission lines in the corridors of the western states, are the Allen Warner Project and the Intermountain Power Project. These lines would have as much, if not more, impact as the Kaiparowits proposal.

Even without the project, increasing demand for water in the Southwest and Southern California suggest the following trends:

- Use of ground water in excess of recharge rate, especially in agricultural areas, will result in further subsidence of productive land.

- As ground water supplies dwindle, perennial streams would be required to handle water needs. In some cases, this will require importation of water using artificial channels.

- Water quality of perennial streams will continue to decline as upstream uses increase.

- Unless perennial streams are developed to handle agricultural needs, productive farmland may be retired as ground water supplies dwindle.

- Environmental impacts on the flora and fauna from additional power lines would be similar to those that would be caused by the proposed action.

Without the Kaiparowits Project, urban growth may be restricted and increased human development and activity delayed. This would give wildlife populations a reprieve, which would only be temporary if another such project were

constructed in the same area. However, if the project is not approved, the search for an alternate source of energy and increased development would continue to deplete habitat and wildlife. On the other hand, a public and governmental commitment to slow energy development would help to maintain the natural environment and wildlife. In this situation, some changes in life style for at least a portion of the public would be expected.

It is possible that at some future time other energy-related projects could affect Indian lands, due to the location of fossil fuel resources in Utah, Colorado and Wyoming, and the growth of population centers in the Southwest. Social and economic impacts from such developments could result in changing social patterns and attitudes among Indian groups. There would probably be increased sensitivity to aesthetic and environmental encroachment upon cultural values.

Archaeological and historical resources are nonrenewable and finite. Therefore, they can only decrease. Illegal collection of Indian artifacts and vandalism of all types of cultural resources are increasing in spite of the efforts of land management agencies and concerned citizens to protect them. Even without construction of the proposed transmission system, there is likely to be increased theft or inadvertent destruction of these irreplaceable resources in sensitive areas. Increased access would speed up the process.

Recreation of all types will increase, commensurate with population growth and the trend toward more leisure time. A generally universal desire among urban dwellers to escape the cities and enjoy less crowded, natural areas add to the probability of increased recreation activities.

There is nearly universal concern for the preservation of environmental quality in the vast deserts, mountains, and plateaus of the transmission system area. Increasing public awareness should help to ensure that the almost endless variety of valuable recreational, scenic, and cultural resources are utilized for recreation and scientific purposes, yet protected for future generations.

Nevertheless, increasing urbanization, intensive land uses, and associated environmental pollution in the Southwest will continue at current rates because of the attractiveness of the region.

Aesthetic values would not change drastically over most of the area of the system. Low-quality visual resources will most likely remain so, and the best scenic areas will probably be protected as much as possible, with or without the project.

Foreseeable trends indicate that livestock grazing will probably decrease in the future, especially on lands near urban areas. Change agents will be the demand for more wildlife habitat, land for urbanization and recreation, and recreational home sites. Changing ranching economics probably will mean that certain low-capacity ranges will become uneconomical for grazing. This would be especially true for California and southern Arizona regions.

Since the mineral industry is continuing to discover new technologies to retrieve minerals from low grade ores, it is reasonable to assume that many parts of the impact area containing ores which are now uneconomical to mine will become valuable mining properties. Project Independence proposes that the United States become self sufficient in so far as possible in energy resources. If this program is emphasized, increased development can be expected in these areas. Indications are that world trade and market influences will also favor the mining of lower grade ores. Many variables exist which will exert influence including, new discoveries, price changes, new technology, and changes in world markets.

Harvest of wood products in the region will probably decrease not because of lessening demand but because of the emphasis on preserving existing resources for ecological purposes and environmental protection.

Trends indicate that agricultural lands are and will continue to be used for housing and industrial purposes. Growth of the region will probably

continue to take agricultural lands out of production. Agricultural uses may take place on marginally productive lands now considered remote and of poor quality.

Population centers are expanding rapidly and this trend will probably continue in the four states concerned. It is highly probable that additional transportation facilities, such as roads, railroads, and air service will be developed to accommodate the growth. Regardless of whether the project is approved, additional transportation systems will likely be built, depending upon needs, technology, and existing priorities.

Without the project, trends indicate that populations in urban areas along the proposed transmission routes will probably continue to grow and that remote rural populations will continue to decline.

The trend of establishing rural residences farther from Phoenix will become more popular in the future, along with growth in the metropolitan area. The Phoenix and Tucson metropolitan areas have attractive labor resources in addition to climatic advantages for industry. In addition, retirement and recreational facilities are expected to increase. In southern California, Orange County, and the western parts of Riverside and San Bernardino counties will continue to increase in population. Population growth in the Las Vegas area will also continue.

There is a concern by some members of Indian tribes to restore and preserve past cultures and life styles. There may be a decrease in individuals who would abandon their heritage for the Anglo-American lifestyle. The effect, if this pattern increases, would bring a renewed interest in preserving the past and would tend to polarize the Indian peoples. On the other hand, attempts by tribal governments to provide education, services, and employment may irretrievably set aside past life style for a compromise between Indian and other cultures. Non-Indian cultures and attitudes are not expected to undergo any significant change in the foreseeable future.

U.S. DEPARTMENT OF THE INTERIOR

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